Alberta

SUSTAINABLE RESOURCE DEVELOPMENT

MONITOR PLOT SURVEY MANUAL

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Table of Contents

1.0 INTRODUCTION 1
1.1 Background 1
1.2 Objectives 1
1.3 Goals 1

2.0 PROCEDURES 3
2.1 Plot Description 3
2.2 Monitor Plot Types (Old Classification Used) 4
2.2.1 Monitor Plot Type Update 4
2.2.2 Monitor Plot Type Codes 5
2.3 Monitor Plot Selection 7
2.4 Remeasurement 7
2.5 Plot Layout 8
2.6 Photography 10

3.0 FORM DESCRIPTIONS 11
3.1 AREA ONE 11
3.2 AREA TWO 12
a) AFS SEQUENCE NO. 12
b) LEGAL ADD 12
c) COVER 12
d) DENSITY 12
e) HEIGHT 12
f) SPECIES 13
g) ECOREGION 13
h) SITE TYPE 13
i) PREP 13
j) TREAT 14
k) BLOCK ELEVATION 14
l) ASPECT 14
m) SLOPE PERCENT 14
n) POSITION 14
o) EXPOSURE 14
p) TEXTURE 14
TEXTURAL TRIANGLE USED TO GROUP AND ASSIGN MONITOR PLOT CODES 15
(ARSOM, 1977) 15
q) DRAINAGE 16
r) HUMUS-DEPTH 16
s) VIABLE SEED 16
t) GERMINATION 16
u) HARVEST EQUIPMENT 16
v) RETREATMENT TYPE 17
w) SKID DATE 17
x) SCARIFICATION DATE 17
y) TREATMENT DATE 17
z) RETREATMENT DATE 17
3.3 AREA THREE – "A" 17

3.4 AREA THREE – "B" 19
3.5 AREA FOUR – "A" 20
i. TREE RECORD 20
ii. BIRTH YEAR 21
iii. DEATH YEAR 21
iv. MICROSITE E S A (Microsite Elevation – Slope – Aspect) 21
CODES FOR MICROSITE ELEVATION OF TREES 23
v. ORIGINALS B. (Original Seedling Seedbed) 24
3.6 AREA FOUR – "B" 24
a. HEIGHT (CM) – (Tree Height in Centimetres) 24
b. CALLIPER (MM) – (Tree Calliper in Millimetres) 25
c. COMPETITION HEIGHT AND TYPE 25
d. DAMAGE or DEATH (Case of Seedling Damage or Death) 26
e. DEATH (Death of Seedlings) 26
f. CURR S.B. (Current Seedling Seedbed) 27
3.7 AREA FIVE 28
3.8 AREA SIX 28
a. Map 28
3.9 AREA SEVEN 29
a. Comments Section 29

4.0 DATA STORAGE/ANALYSIS 30
4.1 Data Storage 30
4.2 Analysis 30

5.0 PHYSICAL LAYOUT – TYPICAL PLOT LAYOUT IN A CUTBLOCK 32

6.0 ECOREGIONS 33

7.0 MONITOR PLOT TALLY FORM 34

8.0 CODE DESCRIPTIONS 35
SITE CATEGORIES 35
VEGETATIVE COVER 35
NON-VEGETATIVE COVER CODES 36
DISTURBANCE CODES 36
MIXED SEEDBEDS 38

9.0 MONITOR PLOT PHOTOGRAPHS 39

10.0 ELEVATION OF BENCHMARKS 47

11.0 REFERENCES 48

1.0 INTRODUCTION

1.1 Background

With accelerated use of Alberta's forest resources, there is a need to develop silviculturally and economically sound reforestation practices. Such practices require the detailed knowledge of successional processes, which occur naturally, and following a variety of site treatments. These processes influence establishment, mortality and growth of crop trees and the associated, vegetative community (see attached diagram from Kimmins, J.P. 1985. Future Shock in Forest Yield Forecasting: The Need for a New Approach. For. Chron. 61:503-507). Current understanding of successional pathways in pine and spruce forests is incomplete, and therefore this study was initiated in 1982 to develop an understanding of stand succession.

1.2 Objectives

To monitor the successional development of the juvenile (0-40 years old) forest community, following natural or artificial reforestation and a variety of site preparation methods.

1.3 Goals

(a) To Establish a monitoring system to provide data from which models of juvenile stand development can be constructed.

(b) To use collected data to determine relationships between pathways of natural succession and post harvest treatments, to help fine-tune primary and secondary reforestation treatments.

(c) To monitor the successional forest community by reporting on the following specific inquires:

1) Is the current scarification practice of dragging and acceptable method of regenerating cutover forest land?

2) Is there a predictable relationship between ingress, a known seed source, and seedbed over time?

3) Is seeding combined with a known and measured scarification technique an effective method of regenerating cutover forest land?

4) Is planting an effective method of regenerating cutover forestland? What kind and degree of mortality is to be expected?

5) In terms of survival and/or growth, does planted stock perform significantly superior to post harvest/scarification invading species?

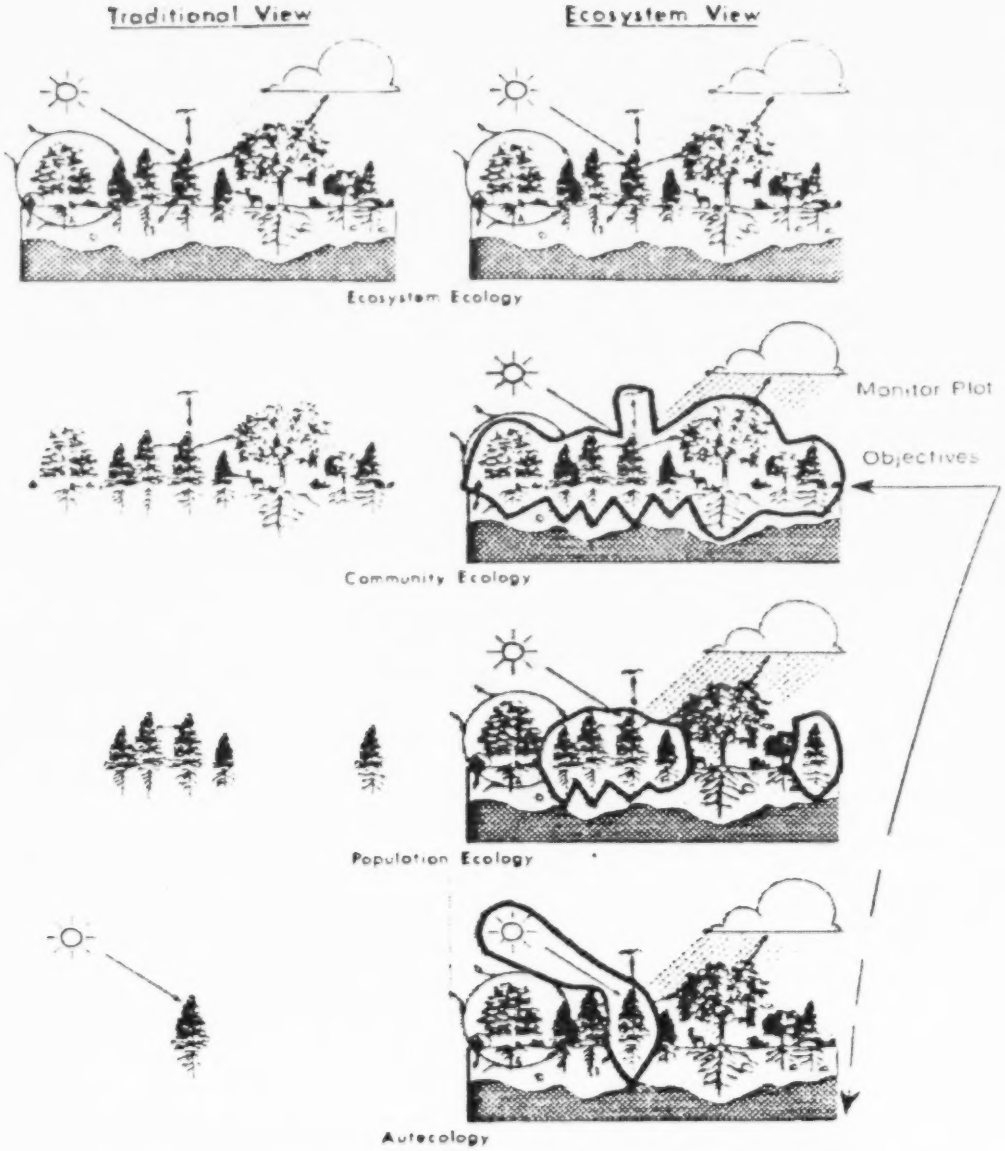


Figure 2 "Traditional" and "Ecosystem" views of the subdivisions of ecology. In the traditional view, ecosystems are disaggregated into biotic communities (biotic community is the focus of attention); biotic communities are disaggregated into populations (individual species populations are the focus of attention); populations are disaggregated into individuals (the individual and its physiology is the focus of attention). In the ecosystem view, the attention may focus on any one of these levels of biological organization, but always in the context of the ecosystem framework in which the level exists. The ecosystem view ensures that all major determinants of events or conditions are considered no matter what the focus of attention. Prediction of future events at the individual, population and community level is likely to be much more successful using the "ecosystem view" than the "traditional view."

2.0 PROCEDURES

2.1 Plot Description

A "Monitoring Plot" is a permanent sample plot designed to monitor juvenile stand establishment and growth on cutover areas. It consist of:

(a) Three to Eight 25-meter long lines established throughout the cut blocks being sampled.

(b) Each strip will have 10 quadrats established alternately on each side of the line.

(c) Each quadrant will be 2.0 by 2.5 meters in size with the long axis lying in the direction of the line. A portable aluminum frame will be used at time of measurement to physically define this area (basic sampling unit).

Frame used to define a quadrant

(d) Each quadrat will be divided into 20 square sub quadrats, 50cm by 50cm in size. Sub quadrats are defined visually by small notches located along the sides of the quadrat frame. They will be used to record and map seedling locations and to help determine percentage ground cover figures for the quadrant.

(e) At the beginning of each, the first quadrat will always start on the left side.

See Section 5.0 for an illustration of plot, strip, and quadrat layout.

2.2 Monitor Plot Types (Old Classification Used)

The Monitor Plot Types are broken down by Ecoregion, site type, site preparation, treatment and retreatment type employed. The Ecoregions to be studied are derived from Strong and Leggat's Ecoregions of Alberta (1981). The monitor plot study will be concentrated in the Boreal mixed wood, Boreal Northlands, Boreal Subarctic, Boreal foothills, Boreal uplands, Subalpine, and Montane ecoregions of Alberta. Descriptions and maps of these ecoregions can be found in Appendix 2.

The site types studied and derived from the Alberta Forest Service's scarification manual. Descriptions of these types are as follows:

(a) **Pine/Dry**: A dry pine site is one with good internal drainage, coarse textured soils, and a duff layer of 2 to 5 cm. Competition is usually minimal from a small amount of grass and shrubs.

(b) **Pine/Moist:** Moist pine sites have fine textured soils (silt and clay), a heavy duff layer 5 to 20 cm deep, and are associated with alder and black spruce.

(c) **Spruce/Moist**: The site type is found on fine textured soils with a duff layer of 10 to 15 cm (rarely deeper). It is associated with alder, grass, high bush cranberry and various feather mosses. Soils are usually moderately well drained.

(d) **Spruce/Wet**: Wet spruce sites are found on fine textured and/or organic soils with a heavy duff layer (greater than 20 cm). These sites are associated with alder, black spruce, willow and birch. These areas can only be scarified in the winter because of poor drainage the rest of the year. After logging there is usually heavy growth of reed grass (Calamagrostis canadensis).

(e) **Spruce – Aspen/Moist:** Most often found with medium duff (10 to 15 cm) on fine textured soils. Associated with alder, birch, poplar and low and high bush cranberry. Grass and herbs offer heavy competition after cutting. "Maintaining Our Forests" (MOF) cutovers are often developed on spruce/aspen moist sites.

(f) **Spruce – Fir/Moist:** This type is found on a wide range of soils with duff from 10 to 30 cm deep. It is also associated with deep moss cover on the forest floor and contains an abundance of true firs.

2.2.1 Monitor Plot Type Update

At the end of the 1990 field season, it was decided to try a more precise type of site classification system, by using an adjacent leave block beside the monitor plot established for site specific data.

The site was classified using Corns and Annas's Field Guide to Forest Ecosystems of West-Central Alberta for sites in this area and B. Sivak's Field Guide to Forest Ecosystems of South-western Alberta. Only a few sites have been classified by these guides and as the plots are remeasured they will be reclassified.

The site preparation treatments to be studied are grouped under the following categories: drag scarification; patch scarification; blade scarification; plow scarification; hand scalping; discing or tilling, prescribed burning

and no treatment (i.e. not scarified). Drag scarification refers to sites that were scarified with drag chains, crawler tracks, or finned barrels. Patch scarification refers to scarification done with the bracke, mounding bracke or leno machines. Blade scarification describes straight blade, modified blade, and brush rake treatments. Plow scarification includes ripper plow, V-plow and marttiini plows. The final treatment category, discing, includes rototilling, double discing, or breaking plow scarification.

The final digit in the monitor plot type code is reserved for the treatment type. The treatment type describes what, if any, silvicultural treatment was applied to the cutovers following site preparation. It must be employed as a prescribed method to successfully regenerate the area (i.e. part of the original silvicultural prescription). Treatments that are required to later to salvage a reforested area shall be handled as "retreatments", not as part of the treatment type code. This code is only to be used to describe the original set of silvicultural prescriptions levied on the particular block. Additional treatments prescribed for NSR blocks (wholesale failures) will also be handled as retreatments and coded under the "retreatment" category.

The treatment categories identified include: no treatment, direct seed to conifers, seeding to forage species only, seeding to conifers and grasses, planting, herbicide (Hexazinone) and plant, herbicide (glyphosate) and plant, herbicide (2,4-D) and plant. The no treatment category is used when the scarification treatment employed is to be the final step in the silvicultural prescription (e.g. spruce moist blade and leave for natural ingress). The direct seeding categories apply to blocks that were either hand or mechanically planted with either bareroot or container stock. The herbicide and plant categories are used when application of herbicides (either before or immediately after planting) is recommended original prescription. If herbicides are used as an afterthought to salvage a cutover several years later, they should be coded as a retreatment. Currently three herbicides and plant categories have been identified and separated into major chemical compound groups. Common brand names for each group can be listed as follows; Hexazinone – "Velpar and Pronone", Glyphosate – "Vision", and 2,4-D – "Esterone 600".

Combinations of ecoregion, site type, site preparation, treatment and retreatment comprise the possible monitor plot types to be studied. The coding for these types is outlined below.

2.2.2 Monitor Plot Type Codes

Coding sequence

Ecoregion	Site Type	Site Prep.	Treatment	Re-Treatment

		Code
Ecoregion	1-	Subalpine
	2-	Montane
	3-	Boreal Uplands
	4-	Boreal Foothills
	5-	Boreal Mixed wood
	6-	Boreal Northlands
	7-	Boreal Subarctic
	8-	Montane Spruce Dry Warm (MSA)

		Code
Site Type	1-	Pine Dry
	2-	Pine Moist

	3-	Spruce Moist
	4-	Spruce Wet
	5-	Spruce/Aspen Moist
	6-	Spruce/Fir Moist
		Code
Site Preparation	1-	No Treatment
	2-	Drag Scarification
	3-	Patch Scarification
	4-	Blade Scarification
	5-	Plow Scarification
	6-	Hand Scalp
	7-	Discing or Tilling
	8-	Herbicide
	9-	Prescribed Burn
		Code
Treatment	1-	No Treatment
	2-	Direct seed to conifers
	3-	Plant
	4-	Direct seed to forage species
	5-	Direct seed to conifers and grasses
	6-	Herbicide (hexazinone) and plant
	7-	Herbicide (glyphosate) and plant
	8-	Herbicide (2,4-D) and plant
		Code
Re-Treatment	0-	No Retreatment
	1-	Fill in planting (hand Scalping)
	2-	Patch Scarify and Plant
	3-	Herbicide (hexazinone)
	4-	Herbicide (glyphosate)
	5-	Herbicide (2,4-D)
	6-	Thinning/Cleaning
	7-	Ditching/Draining
	8-	Fertilization

Example: Type 43630 is spruce moist site in the boreal foothills that was handscalped and planted with no retreatment.

These codes are for reference purposes and for grouping the plots into replications. The types to be sampled will be determined on a priority basis before each field season begins. Some type may be important while others are rarely, if ever employed in Alberta (e.g. patch scarify and seed to conifers). For this reason, only the most common combinations will be thoroughly sampled. New types can be added as new technologies are introduced or new experimental treatments become more commonly used.

In order to achieve statistical confidence and allow for variation in site characteristics it is proposed that three (3) replicates of each selected monitor plot type be sampled. Four or more replicates may be required for some types if variability within the type is ver high (e.g. spruce wet sites).

2.3 Monitor Plot Selection

Priorities for the selection of types to be sampled will be determined by the Reforestation Branch in consultation with the Forests. Representative sites of the most common sites and treatments should receive highest priority. Problematic sites may also be given priority. Plot establishment during the first few years of the program will be concentrated in the Boreal areas of the province. The sub-alpine and montane regions will also be represented, especially in areas of heavy multiple use (e.g. grazing leases on cutovers). As the monitor plot survey is long-term in nature, it is expected priority site selection will vary over time as management practices change. It should be remembered that unusual or experimental treatments are best monitored using methods other than the monitor plot system.

Sites should be recently treated such that the plot can be established before the end of the first growing season. Where types involving planting or use of herbicides are to be sampled the timing is even more critical. It was decided that plots must be established within one month of planting for spring and summer treatments (May – August). Sites planted in the fall (September – November) can be measured anytime up to the following spring's flush. Establishments in the herbicide and plant categories should be measured immediately following planting to determine a base-line stem and vegetative count (e.g. before aspen/grass is killed by herbicide).

Plots should be in blocks that are representative of the license. Blocks should have fairly homogeneous site characteristics throughout. Since the plots will be grouped together with replicates form other Forests, variation can be reduced by avoiding licenses or blocks that are anomalies. The quality of the treatment applied to the site must be consistent with the expected standards. It is important that the plot be representative of the ecoregion, site type, scarification and treatment type that is being sampled.

The selection of new monitor plot sites will largely depend on the forest's scarification and planting programs. Of the sites available in a particular forest, only those with good access should be selected. Long-term access is important, as the plots will be monitored over 40 years. This consideration however, should not rule out the establishment of priority sites in inaccessible areas. Four-wheel drive vehicles and even helicopters could be used to access important sites. In these situations, factors such as long-term costs, ease of access, and transport of survey equipment must be carefully considered.

Established plots should be mapped and protected with Land Reservations (DRS-280-4 notations). Disposition Reservations will help to avoid land use conflicts and keep the plots relatively safe from disturbance.

2.4 Remeasurement

Measurements will be make at the year of establishment (year 0), after one growing season, and after the third, fifth, seventh, tenth, fifteenth and ever five years thereafter until the 40th growing seasons.

The long term scheduling of plot remeasurement and new establishment is a complex and important process. During the later years of the survey, fewer new plots per year can be established in light of the staggered remeasurement schedule. This limitation on the number of plots that can be reasonably handled should be kept in mind when selecting priorities for plot types to be sampled.

Whenever possible plots should be measured at the same time of your for every measurement (plus or minus two weeks). For this reason the summer field schedule is often built around the remeasurement dates of

existing plots. In many cases punctual remeasurement of plots will not be possible due to scheduling conflicts, weather conditions, etc. Since plots measured at different times of the year are to be compared against each other, an effort must be made to adjust for seasonal changes in vegetation. The point of reference that should be used is the middle of the growing season, just after height growth in conifers stops (about late July). Seed bed condition and vegetative competition (type and height) coding should involve a mental adjustment of what the site would look like at the reference time. For example if the site is being tallied in the late fall, the dead vegetation should be assessed to determine what the site looked like last summer. Likewise, a spring tally would involve estimating what the vegetation looked like in a month or two. Whether a projection is made to the last season or to the next season would depend on which is easiest to do. This decision should be documented on the cover sheet for each plot, and must be consistent for each remeasurement.

2.5 Plot Layout

The establishment of a monitor plot on a particular site represents a long-term investment in time and funding. Therefore, it is important that the plot location and subsequent strip layout be chosen carefully. Again, it is important that the plot is representative of the type being sampled. Differences in site characteristics should be accounted for on a proportionate area basis. For example, if a block has 25 percent of it's area taken up by windrows, then 10 of the 40 quadrats should be on windrows. However, if other blocks in the license or area commonly have a much lower percentage of windrows, then the candidate block should be rejected, or else the strips arranged to represent the prevalent conditions. As a general rule of thumb candidate blocks should be of average size for the license.

Layout should commence with a walkover of the block to be sampled. Variation in site characteristics such as slope, aspect, moisture regime, vegetation, and especially treatment quality and intensity should be evaluated. The survey strips should feature the variation in scarification/treatment characteristics primarily, on a proportionate area basis. Variation in site characteristics should also be featured, on a similar basis, but his concern should be secondary in nature. Above all, layout must consider the variability of plot data, which should be minimized through consistency in elevation, aspect, slope and soils.

The three to eight strips will likely be spread out over the block, but should be 20 – 100m apart to facilitate field location. Survey strips must be kept off of roads, landings, seismic lines, pipelines, or right-of-ways that may be located within the block. Consideration should be given to future road width, and other disturbances that may disturb plots, otherwise edge effects are considered in measurements.

Once the starting point for the strips have been located they should be permanently blue with 1.5m iron rods. These rods represent the tie points for each strip and should be painted blue and flagged with orange and blue flagging. Standing residual aspen, snags, or nearby slash piles may also be flagged to facilitate relocation. The baseline of a strip is 26m long. The strips are to be aligned at right angles to the direction of scarification/treatment where applicable. This is to ensure an adequate cross section of the treated/non treated area is sampled. This would also apply to planted areas where a direction of planting or spacing can be determined. In areas of random planting, fill-in planting and "no treatment" the strips can be in any direction from starting points. Once the 26m baselines are located and measured they are to be plotted on the sketch map. This drawing is used only to relocate the strips for remeasurement. It should include bearings from each line (starting point) to the next, and estimates of the distances between lines (pacing or topofill acceptable). This traverse should then be tied into a block tie point. Commonly a raod or trail used to reach the site, but may be the intersection of two seismic lines or other prominent feature. The block tie point should be carefully mapped on to a 1:15,000 scale "forest cover" map to facilitate accurate placement of land reservations. Both the strip sketch map and the 1:15,000 scale block map should be included in the plots

report. A mileage should be taken from the initial tie point to creeks, main roads, towers, etc. These mileage points should be marked on a map to facilitate the location of the plot in the future. Additional copies should be sent to the Forest Headquarters for their reference (e.g. Silvicultural Forester).

Once the three to eight lines have been located and mapped, the individual quadrats can be laid out. The quadrats are physically defined by 2.5 by 2.0 m portable frame. It was designed to fit snugly over aluminium pegs, to allow for repeated accurate measurements of the quadrat over the years.

The "quadrat" pegs are laid out in a line beginning from the starting point of each line (e.g. iron bar). The 90 cm bars are firmly embedded in the ground, in a straight line, 2.5 m apart. The first peg is usually offset from iron tie bar to ensure that the post does not affect the study area.

Where obstacles prevent the proper placement of the pegs, opposite corners of the quadrat may be staked.

The row of pegs identifies the corners of each quadrat (and holds the frame in place) comprise lines. There are ten quadrats per line. The quadrats are on alternate sides of the line, always beginning on the left hand side of the line nearest to the tie post. The frame fits over each pair of pegs such that the pegs are always on the inside of the frame. The lines are numbered 1 through 8 and the quadrats numbered 1 through 80.

Once a line had been staked it must be protected from accidental or deliberate destruction. Two small (30 cm) iron rods are used to permanently mark each line. They are embedded at each end of the strip line, 50 cm from the first and last aluminium pegs. Only 2-5 cm of each rod should be visible above ground level. While these pegs cannot prevent the removal of survey posts, they do allow for the accurate re-establishment of damaged lines.

In cases where whole lines are destroyed, and the ground surface disturbed, abandonment of the line and/or plot should be considered. Undisturbed plots with three lines remaining can be salvaged and included in the data pool. Lines with two or more disturbed quadrats should be abandoned.

The actual field tally is on a quadrat-by-quadrat basis. The aluminum frame, which defines the quadrat perimeter, is marked at 50 cm intervals. These marks are used to gauge the subquadrats (20-50 cm x 50 cm divisions). The subquadrats are used for mapping seedlings and for recording site conditions. These subdivisions are numbered as per the "seedling frequency count" diagram on each tally card.

Seedlings, advanced growth, or competitive vegetation will be considered to be "in" a quadrat if the "root collar" of the plant material in question originates within the perimeter of the frame. The frame border itself is not to considered part of the sample area, and all vegetation originating directly under it should be excluded from the tally. Seedlings or advanced growth, which lean into or out of the quadrat, are to be included in the sample only if their point of origin is within the quadrat perimeter (e.g. layered fir trees).

The seedlings that are to be tallied must be numbered for accurate field identification during remeasurements. Plastic horticultural stakes (12 cm) have been used to successfully "pin" germinants for up to 3 years. Metal tree tags work well for larger saplings and planted stock. Tie these metal tags to a branch of the tree if possible and not around the stem to reduce to chance of girdling the tree. As time progresses, move the tag to a higher branch on the tree. This will help to find a line when going through a dense tree and shrub plot.

Locating and Tagging Seedlings in a Quadrant

2.6 Photography

To provide a visual reference of change over time, photographic records of many plots will be maintained. Present plans call for at least one replicate per type to be photographed at each and every remeasurement. However, more than one replicate may be photographed if the site is of particular interest. The first pictures for a plot should be representative overviews of the block, showing treatment quality, slash accumulation, topographic features, etc. Then one photo illustrating the ground cover along strip 1 should also be taken. To maintain consistency through the years the photo must be taken in the same place at each measurement. It is suggested that the camera body be placed on the tie point bar and its lens centred on the top of the last aluminium peg in the strip. Overview pictures of all plots should be taken (total of five or six pictures) from the beginning of each line. Use a sign with plot number and date in each photograph.

Overhead shots will then be taken of each of the 40 quadrats using an automatic camera, overhead boom equipped with a balance bubble. Once trees become too big, this practice will be discontinued.

Overhead camera boom used to photograph each quadrant

Resulting overhead view of quadrant

Each quadrat in the series will be identified by a number in the lower left or right hand corner of the photo. The camera frame number for a particular quadrat should also be noted on the tally sheet in the space provided. Individual seedlings may be identified in the photographs by placing a large plastic number stake nearby. This is only intended to provide clarity on sites where individual seedlings are of significance (e.g. genetically improved outplantings). It is not necessary to stake every seedling prior photographing, as seedlings smaller than 10 cm in height are rarely visible in the resulting overhead pictures. The above photographs illustrate the use of the camera boom in the field.

3.0 FORM DESCRIPTIONS

Once the three to eight -strip lines have been laid out, the actual tally can begin. The Plot data, Quadrat data, and Tree data are recorded on the same tally form: RR 101 (see Section 7.0). This form has been significantly changed a number of times. Each change represents a modification designed to improve sampling accuracy, efficiency and computer analysis.

The Monitor Plot (Survival) Form is "blocked" into seven page areas of data organization. The current form is designed to mimic the keypunching windows for easy input. At the beginning of the 1989 field season, a field computer (PC 9800) was purchased for tree measurements. On plots to be remeasured, the program prompts you for this year's measurement data and error checks your data input. In the future, the only variables to be entered on this form are the plot number, date, surveyors, camera frame number, seedbed percent and location of trees. A comment section is provided and it would be to your advantage to take the report file from each plot and keep it in your vehicle. This report file contains a printout of the last remeasurement data in case the PC 9800 fails for any reason.

3.1 AREA ONE

The top of the tally form is reserved for the record of the plot, date and descriptive information. The plot number is a 5-digit number that applies to that plot only. The date box is filled in with the appropriate year, month, and date. The shaded box to the upper right provides a guide for a number of pages on a given plot, who surveyed the block and the camera frame record as it applies to each quadrat.

3.2 AREA TWO

This information is data that is specified for the entire block (plot). It should be completely filled in when a plot is established and does not need to be entered again. The only exception to this is if some of the information is found to be incorrect or if the information changes for some reason (e.g. if a block is restricted). The information contained in this section will be described from the upper left hand corner, to the bottom right hand corner.

a) AFS SEQUENCE NO.

This is the TM 250 number. This number corresponds to the particular cut block the plot is located in. The Reforestation Branch maintains a silvicultural database using the same number sequencing (TM250). This number allows for easy cross-referencing of important cut block information; which is from time to time, updated. It is made up of a three digit township number (001 – 126); two digit range location (01-30); a digit for the meridian (4, 5, 6); and a four digit cut block number (0001 – 9999). The TM250 number, along with the L.S.D and Section Numbers, provides an accurate legal description of the plot's location. Survey lines that fall in different Townships or ranges should be handled in the same manner as the L.S.D./Section parameters.

b) LEGAL ADD

This is the Legal Sub-Division and the Section, the legal location of the survey lines down to the nearest legal subdivision. In cases where the lines may be located in different L.S.D..'s (or even sections) the L.S.D. or section where the majority of the lines lie, should be recorded.

c) COVER

This is the Phase III Photo Interpreted Overstory: the field type coding for the original overstory (just prior to harvesting/removal). This information should be obtained from the most recent "Phase 3" interpreted maps of the license. The coding scheme follows that use by the Forest Measurement Section of the Timber Management Branch. The data is left justified and recorded as a density code, height code, and species composition. Coding is as follows:

d) DENSITY

CODE	CROWN DENSITY %
A	6-30
B	31-50
C	51-70
D	71-100

e) HEIGHT

CODE	STAND HEIGHT
0	0-6.0 m
1	6.1-12.0 m
2	12.1-18.0 m
3	18.1-24.0 m
4	24.1-30.0 m
5	>30.0

f) SPECIES

Composition is listed as a percent of the gross roundwood (13/7) volume for stands over 12 m in height. For stands under 12 m the crown cover is used to determine species composition. Species is recorded in order of decreasing content up to a maximum of three species above 20 %(major). Species comprising 11 – 20 % of the crown cover are recorded in the brackets at the far right. Species 10 % or less are not recorded. The species codes used are the same as those listed in Section 3.3B – "acceptable species". Starting in 1999 an AVI call is to be made after the plot has been re-measured. Use the area around the lines for this interpretation. Do not zero-fill spaces.

g) ECOREGION

Since we are going to reclassify the sites, the following two variables (Ecoregion and site type) will eventually be changed according to the Monitor Plot Type.

There are seven acceptable Ecoregion codes for entering into this box. They are defined by Strong and Leggat in "Ecoregions of Alberta". Acceptable ecoregion codes are:

1- Subalpine
2- Montane
3- Boreal Uplands
4- Boreal Foothills
5- Boreal Mixed – Wood
6- Boreal Northland
7- Boreal Subarctic

h) SITE TYPE

There are six acceptable Site Type codes for entering into a box. The source of these types is from the Alberta Forest Scarification guide. Acceptable site type codes are:

1- Pine Dry
2- Pine Moist
3- Spruce Moist
4- Spruce Wet
5- Spruce/Aspen Moist
6- Spruce/Fir Moist

i) PREP

Prep refers to site preparation method. There are currently 20 acceptable codes for site preparation methods. As new technology becomes available, more coding types may have to be added. The current accepted codes are:

1- Blade
2- Bracke
3- Brush Blade
4- Brush Rake
5- Disc
6- Donaren
7- Double Disc
8- Double Offset + Eden
9- Drag
10- Drag + Delimb at Landing
11- Hand Scalp
12- Leno
13- Marttiini
14- Mod Blade
15- None
16- Presc. Burn
17- Ripper
18- Rome + Eden
19- Sharkfin
20- Double Bedding Plow

j) TREAT

Treat refers to the reforestation treatment done on the block. There are 12 acceptable codes for this box. The current acceptable codes are:

1-	1-0 CPL	7-	Natural
2-	1-0 CSW	8-	Seed PL+ SW + FD
3-	2-0 BPL	9-	Seed Mx
4-	3-0 BSW	10-	Seed PL
5-	Aerial Seed	11-	Seed SW
6-	Forage Seed	12-	Seed SWPL

k) BLOCK ELEVATION

Is the elevation of the cut block and/or area where the majority of the survey lines lie; four digits, elevation in metres above sea level. Set an altimeter using a bench-mark site (Appendix – Figure 7) and record the true elevation on the form.

l) ASPECT

The general block aspect or orientation: 1letter, "N" – North, "S" – South, "E" – East, "W" – West, or the cipher "O" for blocks with no discernible aspect.

m) SLOPE PERCENT

The average percent slope over the cutblock; two digits, 00 (Flat) –99.

n) POSITION

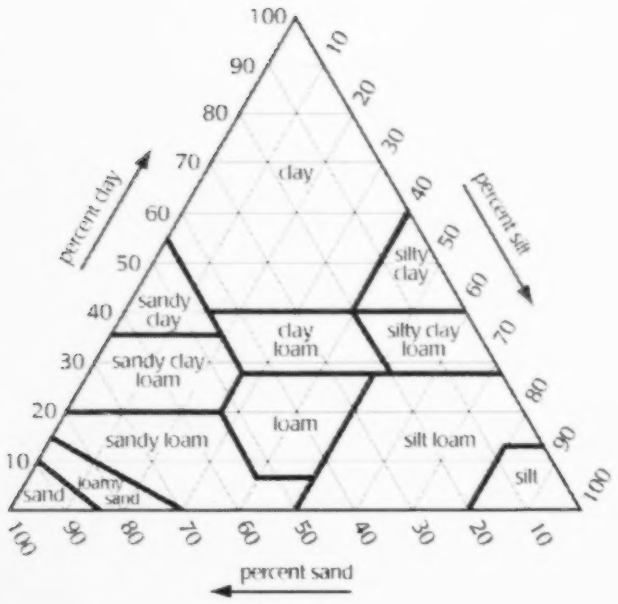
Refers to the relative topographic position of the cutblock in a hydrologic sense. Code 1 for blocks located on ridge crests – shedding water; 2 for block on upper slopes – shedding water; 3 for blocks midslope; 4 for blocks along lower slopes receiving water; and 5 for blocks located in local topographic depressions – collecting water.

o) EXPOSURE

Mineral soil exposure on mechanically scarified blocks. This figure need only be calculated for blocks that were drag, blade, plow, or disc scarified. Several line transects should be used to estimate the mineral soil exposure in the vicinity of the survey lines; 1 digit, code "**1**" for 0-10%, "**2**" for 11-20%, "**3**"for 21-30%, "**4**" for 31-40%, "**5**" for 41-50%, "**6**" for 51-60%, "**7**" for 61-70%, "**8**" for 71-80%, "**9**" for 81-90%, "**10**" for 91-100%, "**11**" for Missing.

p) TEXTURE

The texture of the exposed mineral soil in the vicinity of the survey lines. The soil that constitutes the majority of the potential seedbed/planting sites is of primary concern here (usually A or B horizons). The texture can be estimated by manually texturing but ultimately soil samples should be collected from the block. About 15 core-sample should be taken throughout the plot, and then mixed together and a small sample sent off to the laboratory for analysis. The standard textural triangle is used to code the following entries: **1-** Clay; **2-** Silty clay; **3-** Silty clay loam; **4-** Clay loam; **5-** Sandy clay; **6-** Sandy clay loam; **7-** Sandy loam; **8-** Loam; **9-** Silt loam; **0-** Silt.



TEXTURAL TRIANGLE USED TO GROUP AND ASSIGN MONITOR PLOT CODES (ARSOM, 1977)

q) DRAINAGE

This is a subjective assessment of the internal drainage characteristics of the cutblock. Factors such as slope position soil texture, humus depth and location of the water table should be taken into consideration. Evidence of flooding, ponding, water erosion and soil mottling may also suggest the drainage regime of an area. The drainage codes used vary along a simple continuum from very rapidly drained to very poorly drained. Appendix 5 describes the eight drainage categories used in more detail. They are coded as follows: **1-** very rapidly drained; **2-** rapidly drained; **3-** well drained; **4-** moderately well drained; **5-** imperfectly drained; **6-** imperfect to poorly drained; **7-** poorly drained; **8-** very poorly drained.

r) HUMUS-DEPTH

HUMUS-depth refers to the average depth of the duff layer (organic matter) on the block, before disturbance. The depth is measure from the top layer (usually litter) to the mineral soil. It is recorded as a single digit using the following codes: **1-** very shallow (0-5 cm); **2-** shallow (5-10 cm); **3-** moderately deep (10-15 cm); **4-** deep (15-20 cm); **5-** very deep (> 20cm);

s) VIABLE SEED

Viable seed registers only on seeded blocks. This number is based on three factors; germination per cent of seed, seeding rate, and an estimated of seeds/m^2 made by field staff immediately following seeding. If this value is unavailable, "00" is entered.

t) GERMINATION

The stratified germination per cent of the seedlot used to treat a block. This figure is available from the seeding report for the license. Per cent germination values are provided by the laboratory at the Provincial Nursery for each seedlot cleaned and stored. The stratified figure should be used in calculating the number of viable seeds per square meter: 2 digits, 00-99%.

u) HARVEST EQUIPMENT

The method used to clear the site or remove an overstory. This information will be used to indicate the nature of the on site disturbance, prior to site preparation. The category which best describes the original disturbance should be recorded, even if a combination of methods were employed during harvesting/clearing. The possible categories are as follows:

1. Blade + Burn
2. Clear + Pile Burn
3. Feller Buncher/Delimb at Landing
4. Feller Bun/Delimb Land/Piles
5. Burnt
6. Missing
7. Natural Burn
8. Other Methods/Equipment
9. Power Saw/Skid Removed
10. Wind row
11. Wind row/Pile Burn
12. Walked down Aspen
13. Windthrow

v) RETREATMENT TYPE

The type of retreatment (if any) applied to the cutblock to enhance seedling growth or salvage N.S.R. areas. A retreatment type code should only be entered after the work has taken place. Until such time a zero should be entered in this column (no treatment). The various re-treatment categories can be listed as follows:

0 - No treatment
1 - Fill in planting (hand scalp)
2 - Patch scarify and plant
3 - Herbicide (hexazinone)
4 - Herbicide (glyphosate)
5 - Herbicide (2,4-D)
6 - Thinning/Cleaning
7 - Ditching/Draining
8 - Fertilization
9 - Seed

w) SKID DATE

The month and year the cutblock received skid clearance (from the TM250 report for the block). If the block was cleared for afforestation, (e.g. M.O.F. areas) the month and year of clearing should be entered. If the block being treated is in a recent burn, then the date of the fire should be entered. When burned over areas or wind-thrown stands are salvaged logged, the date of final skid clearance should be recorded; 2 digits – Month, 2 digits – Year. Enter "0000" if not harvested or cleared.

x) SCARIFICATION DATE

The month and year the plot area was scarified. This information is recorded on the TM250 record for the block. However, it is better to check with the field forester to confirm the actual date of scarification in the plot area; 2 digits – Month, 2 digits – Year. Enter "0000" if no site preparation was undertaken.

y) TREATMENT DATE

The month and year the plot area received some form of silvicultural treatment (see section 2.2). Only the treatments listed previously qualify. As well, it must be employed as a prescribed method to successfully regenerate the area (e.g. original silvicultural prescription). The TM250 records can be used to obtain this information, however, it is best to check with the field forester. As with the scarification date, the TM250 records only indicate the number of hectares treated, and not the treatment location.

z) RETREATMENT DATE

If the block received any secondary treatment, the date of the treatment is recorded. If no secondary treatment has taken place, then enter "0000".

Pre-harvest assessments are to be done on an adjacent stand if possible. These are only done once. If no suitable stand is nearby, do the PHA near old stumps where no scarification has occurred.

3.3 AREA THREE – "A"

QUADRAT NUMBER – The first information to enter in this area is the quadrat numbers. This number will normally be from 01 to 40, but in some cases is greater than 40.
The top of this box area is information that is filled in once when the plot is established. During plot establishment each quadrat is to be examined for the presence of seed bearing cones. Only unopened serotinous or semi-serotinous cones located within a quadrat are to be counted. In most cases these cones must be mature and no more than one to two years old. The following table lists the species of cones that are considered acceptable:

Species	Conditions
1. Lodgepole Pine (PL) Jack Pine	• Cones must be mature • Unopened; can be 1 to 4 years old. Typically no more than 2 years. • Can be on ground or in suspended slash as long as cone rests directly above plot.
2. Black Spruce (SB)	• Cones must be unopened. • May be in final stages of maturity of fully mature. • Should be no more than 1 to 3 three years old. • Can be on ground or in suspended slash.
3. White Spruce (SW) Larch (LT) All Firs	• It must be observed to be actively casting seed on to the quadrat. • Most cones should be mature and at least partially opened. • Cones must be from the current year's crop. • Must be in suspended slash directly over quadrat. • Rarely, if ever, recorded

The number of acceptable cones located within a particular quadrat is the actual number of cones found on the quadrat.

The type and cones/quadrat category are entered as follows:

CONES					
Primary			Secondary		
P	L	**Actual Number**			

Columns 33 –35 indicate the primary species of cones observed on a site (e.g. the most abundant). If two acceptable species of cones are present on a particular quadrat, then the second most abundant species is coded. The some letter/number category system is used to classify secondary cones.

CONES					
Primary			Secondary		
P	L	**Actual Number**	**S**	**B**	**Actual Number**

Only two acceptable species of cones are to be recorded for any one quadrat. The estimate of type and numbers of cones is to be evaluated upon plot establishment only. Thereafter, the original cone tally should be copied into the spaces provided. If no cones are observed on the quadrat at establishment, simply enter "000,000"

SEED SOURCE – Is the distance, in meters, to the nearest potential wind-borne seed source. To qualify as a seed source the stand and/or trees must have the following characteristics;

Only coniferous species with non-serotinous or semi-serotinous cones will be considered.

Seed tree must be alive and capable of providing wind-borne seed (e.g. mature).

Should be close enough to the quadrat that at least some of the seed cast has a reasonable chance of landing within the frame boundaries. Generally the seed source should be no more than 100 meters away to qualify.

The area directly between the seed source and the quadrat should be free of wind barriers and other obstructions (e.g. Dense aspen overstories, steep hills, etc.).

Where two or more possible sources of wind-borne seed exist near a plot, choose the one with the best chance of casting the most seed (e.g. note prevailing winds, proximity to plot, current years cone crop etc.). Most often, the seed source noted is the uncut residual block of timber. Nearby "seed trees" on partial cuts are also recorded as well as healthy "wolf trees". On plots where no coniferous seed source exists, "000" is recorded as the distance to seed source (e.g. afforestation areas, M.O.F.blocks).

3.4 AREA THREE – "B"

PLOT SEEDBED PERCENTAGES – Site condition assessment, on a per quadrat basis, to provide an overview of each 5 m^2 sampling unit. The site condition codes (see section 3.3c and appendix 5) are used to describe the vegetative cover, non-vegetative cover, site disturbance, and the physical condition of the potential seedbed of each quadrat.

The site condition assessment is represented on a percentage ground cover basis. Various site condition code-types are first identified on a particular quadrat and mentally lumped together into homogeneous groups. The proportion of the quadrat that each identified type represents is then visually estimated. The Values from 1 to 10 corresponding to the percent cover for each code type encountered are then assigned to the appropriate field (in increments of 10%). On the tally card, these entries are recorded directly under the number representing each code type (types 1 – 20). For example, a particular quadrat is covered by approximately 10 % heavy grass, 40 % shrub species and the remaining half by mixed soil and duff. The Plot Seedbed percent for this quadrat would be recorded as follows:

PLOT SEEDBED CODES (%)																		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1			4					5										

All site condition entries must add up to 10 (100%) for each quadrat. The computer will only accept a code up to 90% so there cannot be any 100% codes. It is not necessary to zero-fill the remaining code types (codes not observed on quadrat). The Plot Seedbed percentages are to be filled out at each and every measurement as they provide a direct indication of changes to ground cover over time, on our cutblocks.

3.5 AREA FOUR – "A"

i. TREE RECORD

Individual tree data is to be input into the PC 9800 where the previous tree measurement data is shown. Care must be taken when inputting the data because once you say "N" to any changes, the data is written to the file. The following refers to entering tree information on paper. This information pertains to each individual tree tallied on the quadrat. The tree record is in the form of a matrix with various measurement parameters listed along the top (x-axis) and the individually numbered trees along the y-axis. The tree record matrix is located in the lower left hand corner of the tally card. There is enough space on each tally card to enter 45 individual tress[1] (and/or seedlings). If a particular quadrat contains more than 45 trees, additional pages may be added. In such cases, only the Header data and page number need be recorded on the additional pages (e.g. Page 3A, 3B, etc.). If a quadrat is void of any "acceptable" stems, simply print "no tally" in the middle of the tree matrix.

The following is a breakdown of the type of information recorded as Tree Data (on paper and on the PC 9800).

TREE NUMBER – The number assigned to represent a specific tree. Once a number is assigned to an individual tree or seedling, it cannot be **used again**. At establishment, trees are usually numbered in order, starting at 001, 002, 003, etc. At remeasurement, new seedlings (e.g. ingress) are assigned numbers in sequence starting after the last number used. Trees that were missed or overlooked during previous measurements are numbered in the same fashion using new numbers.

SPECIES – this is the two-digit letter code for the particular tree being tallied. The acceptable species and their corresponding codes are listed in section 3.3A of this manual. The tree species call, like the tree type entry, must remain the same from measurement to measurement; unless an error was made in species determination. All letter entries used for this parameter (and others) are to be capitalized.

SQUAD – Subquadrat Number provides the approximate location of the seedling or tree within the quadrat. Twenty subquadrats make a quadrat and are numbered as shown on the seedling frequency count (appendix 1 – quadrat dimensions). Simply enter the number of the subquadrat where the seedlings point of origin is located. If the stem is in the border between two subquadrats, enter the subquadrat number where the majority of the seedlings crown exists.

PM (Planting Method) – Refers to the type of tree being recorded. There are four acceptable codes that can be entered. These codes are:

[1] This includes the back of the Tally form.

Code

B- if tree measured is a nursery grown bareroot seedling. Seedling can be any species, or stocktype (e.g. 3-0 spruce, 2-0 pine).

C- if tree measured is a nursery grown containerized seedling. Can be any species, stocktype or container type.

I- is for ingress.

A- if tree measured has the characteristics of advanced growth. The seedling or tree must meet the following requirements:

1. Seedling must have grown on site for at least one year prior to harvesting.
2. Seedling must show good health and vigour and will probably be alive and merchantable when the rest of the established trees are harvested.
3. Seedling must posses an undamaged, well-defined single stem. Should appear normal form for the species.
4. Must have originated from seed rather than layering.

Trees tallied as advanced growth are usually at the "sapling" stage of development (e.g. balsam poplar, aspen). Sapling trees generally have stem sizes between 1.1 cm and 9.1 cm D.B.H. (P.S.P. Manual, Forest Management). However, trees with smaller diameters may be recorded as advanced growth as long as they meet all of the requirements described above (e.g. slow growing firs).

ii. BIRTH YEAR

This number is the year that first appeared on site. In some cases it is difficult or impossible to correctly age seedlings, due to broken or damaged stems, etc., but try to estimate the trees age.

iii. DEATH YEAR

This number is the year that the tree died. Due to the sampling intensity of monitor plots, it should always be accurate within ± two years.

iv. MICROSITE E S A (Microsite Elevation – Slope – Aspect)

E - Microsite Elevation. This is the position of the seedling's seedbed relative to the original ground level (prior to disturbance). Seedling microsite position will be assessed at the seedling's point of origin.

Code	Elevation
1	Seedling seedbed above original ground level by 5 cm or more.
2	Seedling seedbed the same (±4.9cm) as the original ground level.
3	Seedling seedbed below original ground level by 5 cm or more.

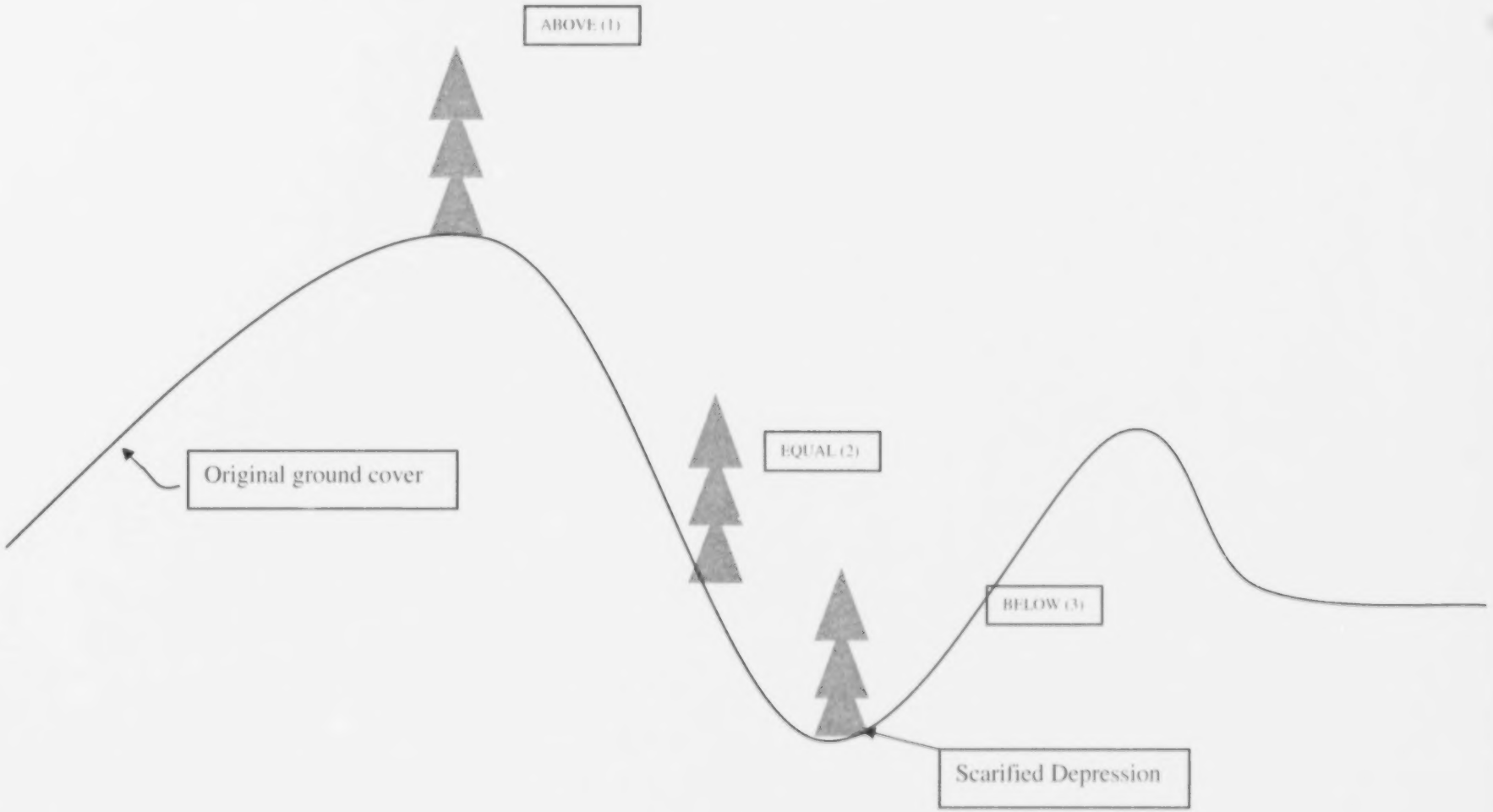
Most seedlings will be tallied as having microsites level or nearby level with the surrounding ground surface (code 2). The microsite elevation call was primarily designed to classify seedling position relative to the scarification profile (e.g. top of marttiini mound, bottom of bracke scalp, etc.). The figure below provides a cross-

sectional view of a typical scarification profile and illustrates the three microsite elevation calls.

S - Microsite Slope. The microsite slope code was designed to indicate the slope of the seedbed surrounding the seedlings point of origin. The simplest way to assess this parameter in the field is to examine a small area as a plane; estimate its approximate percent-slope; and select a corresponding percent slope category (10% intervals). The categories and the codes tallied are described below:

Code	Description
1	Level – 0 to 10% slope
2	Slight slope – 10 to 20% slope
3	Moderate slope – 20 to 30% slope
4	Steep slope – 30%+ slope

Most seedlings will fit into category 1. This parameter serves to highlight trees or seedlings growing out of slash, or scarification debris at acute angles. Seedlings growing on steep slopes where erosion potential exists, are also highlighted by this call.



CODES FOR MICROSITE ELEVATION OF TREES

A - Microsite Aspect. A one-digit letter code indicating the seedlings aspect (if any). For the purpose of this study, microsite aspect will be defined as a single prominent direction from which the majority of a seedling's light supply originates. In cases where seedling stands alone and free from competitive factors (over-topping vegetation) no aspect should be tallied – code number "0". Aspects (code **N, S, E,** or **W**) may be assessed if the seedling is located on a slope steeper than 10%; which forms a plane lying generally in the given directions. Seedlings completely sheltered from light on three sides should be assessed an aspect corresponding to the direction where the majority of the seedling's light supply originates. This call was designed primarily to highlight those microsites where the interception of light (and heat) may be influenced by location.

v. ORIGINALS B. (Original Seedling Seedbed)

Site condition assessment on a per seedling basis. The same set of codes used to describe the plot seedbed percentages are to be used here. These codes are described in some detail in the following section of this manual (see Section 3 and Section 9.0).

The seedling seedbed field describes the microsite immediately surrounding the individual seedling. An area approximately ten times the diameter of each seedling is to be visually evaluated. In the case of germinants, this call should be a direct indication of the type of growing medium present for advanced stems and planted stock. This particular call is made only once, at time of establishment.

3.6 AREA FOUR – "B"

a. HEIGHT (CM) – (Tree Height in Centimetres)

Is the height of each individual seedling, to the nearest centimetre, at time of measurement. The following schedule is to be used as a guideline when recording seedling/tree height, the plot cover sheet MUST indicate if the present year's growth is included or excluded from the measurement.

	Measurement Season	Height Recorded
1.	Prior to Spring Flush (about May to June)	Total height from point of origin to highest point on leader of seedlings or tree.
2.	During Active Height Growth (spring or 2nd flush to about June or July)	Total height from point of origin to highest node (e.g. height excluding current year's flush or candle).
3.	After Bud-Set (about July to October)	Total height from point of origin to highest point on leader of seedling or tree (including current year's flush, if any).

The above rules should be followed very closely when measuring tree height.

Germinants smaller than 1 cm, should always be recorded as 001, not as 000.

Seedlings with leader damage should be measured from where their stem intercepts the ground (point of origin) to the highest, undamaged part of the leader. In similar cases height measurements may be taken to the top of the lateral branches if they appear to be exerting apical dominance. Trees with multiple leaders (e.g. bareroot spruce) should be measured from ground level to the tip of the highest leader or node,

depending on season of measurement. Deciduous species with multiple stems should be measured in a similar fashion (e.g. stump suckers). It is necessary to zero-fill the height columns.

b. CALLIPER (MM) – (Tree Calliper in Millimetres)

Is the stem calliper of coniferous nursery stock in millimetres. Bareroot and container stock will be measured from establishment on. Calliper is measured approximately 2 cm above the root collar using vernier-type callipers.

To ensure consistent measurements each year, the "2-Finger" method should be used. Simply grasp the seedlings stem between two fingers with your palm flat on the ground. Lay the calliper "jaws" on top of your fingers and close them gently around the seedling stem. Finally, remove them carefully by pulling straight (horizontally) away from the stem. Read the vernier scale to the nearest millimetre. The calliper is recorded with black fields zero-filled where necessary (e.g. 5mm – enter 005). This is to maintain consistent measurements year after year.

c. COMPETITION HEIGHT AND TYPE

This is a two-digit code describing the height and type of competition affecting individual seedlings. Column 44 assesses the competition relative to the height of the seedling.

Code

0- Little or no competing vegetation present.

1- Competing vegetation below seedling height.

2- Competing vegetation equal to seedling height.

3- Competing vegetation above seedling height.

4- Microsite shading (by dead or inorganic materials).

5- Crushing – seedling in close contact with organic/inorganic debris such that physical damage may occur. (Remember to replace debris to minimize the remeasurement disturbance.)

The second column assesses the type of competition present:

Code

0- No competition

1- Herbs, Forbes, etc.

2- Grasses, sedges, etc.

3- Shrubs (non-acceptable species e.g. willows, roses)

4- Trees (acceptable species e.g. Fir, Birch, Aspen)

Competition should be tallied only if the canopy area of competing vegetation overlaps approximately 40 % of the seedling's canopy area. The canopy area refers to the area directly above and below the leaves of the vegetation. If there is a number of different types of competition, the type that occupies or intercepts the greatest canopy are of the seedling should be tallied. This dormant competition type may occupy less than 40 percent of a seedling's canopy area (approximately 30 %) if combined with other vegetation types. The height of the competition is evaluated by distribution of competing leaf surface area relative to the height of the coniferous seedling. The two factors of height and density of competing leaves must be weighed together. It was decided that height would have more weight than density of leaf surface area when overtopping occurs. Significant overtopping is roughly defined as having at least 20 % of the competing leaf surface area above the height of the seedling.

Competition will be tallied as above if the seedling is significantly overtopped by competing vegetation. Competition is to be tallied as equal to if the competition is approximately the same height as the seedling. There can be some overtopping but not a significant amount (less than 20 percent leaf surface area). The densest competing leaf surface area should be generally the same height as the seedling's densest leaf surface area. Competition will be tallied as below if the height of the competing vegetation is less than the seedling. There must be an insignificant amount of overtopping and the densest competing leaf surface area should be below the seedling's densest leaf surface area.

d. DAMAGE or DEATH (Case of Seedling Damage or Death)

DAMAGE OF SEEDLING

When a damaged seedling or tree (acceptable species) is encountered on site, a specific code is used to indicate a probable cause of injury. For the sake of simplicity, these codes closely resemble the mortality codes in number and description. A damage call can be made for an individual seedling anytime a significant amount of morphological damage has been incurred. In any case, the seedling must still be alive (e.g. possess some succulent plant parts or live plant material). The same call can be made again in subsequent measurements as long as the damage continues.

Whenever a damaged tree or seedling is encountered, the most specific cause of damage should be noted and entered. In cases where several different types of damage affect a seedling, the most serious type should be coded (e.g. rabbit browsed three has some frost damage – code "rabbit browsing"). Unlike coding for mortality, there is no set procedure to follow when recording seedling damage. The individual tree tally fields are filled in as if the tree was healthy. A damage code representing the nature of the injury encountered is then recorded. A vigour code should then be tallied to reflect the seedling's current state of health. The following damage codes should be assigned to acceptable seedlings/trees where and when they apply:

e. DEATH (Death of Seedlings)

When a dead, acceptable seedlings is encountered on a site a mortality code is used to indicate a probable cause of death. For the purpose of this study a dead seedlings will be defined as one that shows no morphological signs of life (ie. has dried leaves, stems, needles, buds, etc.) All dead seedlings /trees are to be tallied as mortality only once (when first encountered) and not in subsequent re-measurements. All dead stems situated within the quadrant at time of establishment, should be ignored.

Whenever a dead "tagged" seedling is encountered the mortality field should be filled in, in the event that cause of death in unclear, code 37 (unknown) shall be used. In cases where two mortality codes apply, always use the more specific code) e.g. tree trampled by unknown causes and browsed heavily by rabbits – tally "rabbit browsing' rather than mechanical damage). Use of the previous year's vigour and damage tallies may provide a more accurate assessment of the cause of mortality.

The following tally procedure should be used when recording individual seedling that have died since last measurement.

- in the death column, choose the appropriate cause of seedlings mortality
- in the D'Year column, fill in the appropriate year of death
- height, calliper, comp. ht. and comp. ty, vigour and curr s.b. are recorded as zero (0)

The number assigned to dead seedlings should not be used again. Once dead, all seedlings/tree tags should be removed. Do not map dead trees on the seedlings frequency count.

VIGOUR (Seedling Vigour) – Each seedling is appraised according to its relative vigor, based on physical characteristic at time of measurement. A one digit code indicates the seedling's/trees state of health as characterized by the following vigor categories.

Codes	Description
0	Normal – Seedling shows average height growth in relation to other seedlings in area. Appears normal in form, colour, and general health for the species. Can show signs of minor injuries (must not significantly effect the growth performance of the seedling).
1	Suppressed – Based on physical position in relation to the vegetative cover on a subquadrat. Seedling must have a severely limited supply of light; suffer from crushing or physical smothering; or show no growth over the previous year. Used in conjunction with an "overtopped" competition code (e.g. 31, 32, 33) to indicate severe growth suppression.
2	Chlorotic – Seedling must show obvious yellowing and/or mottling of leaf colour. Used to indicate a nutrient deficiency or other "internal' disorder (e.g. Must not be confused with herbicide damage).
3	Recovering – Seedling has sustained significant damage; shows signs of recovery. Physical appearance tending towards normal for species)e.g. new leader growth, wound healing progressing, etc.).
4	Regressing – Condition previously documented as damaged; shows signs of further deterioration (seedling must still be alive).

f. CURR S.B. (Current Seedling Seedbed)

The site condition assessment on a subquadrat basis is evaluated at each measurement. The purpose of this parameter is to describe the growing medium/ground cover in the general vicinity of the seedling (0.25 m^2). The code repressing the dominant condition of the particular subquadrat that the seedling is located in, should be recorded. In most cases, the site condition comprising the greatest percentage area will be tallied. To simplify field coding of individual subquadrats, spaces have been provided on the seedling map in which to enter each call. These codes can then be transferred to the subquadrat site condition field for individual seedlings.

Damage indicator – This variable is entered by the computer program.

Damage Indicator

H – Healthy
D – Damaged
M – Mortality

3.7 AREA FIVE

a. Deciduous Frequency Box

The purpose of this section of the Tally form is to provide an accurate quadrat (and plot) density of hardwood deciduous stems. Only three examples of hardwoods is monitored in the tree matrix (AREA FOUR). The deciduous frequency box will be used to estimate number of hardwood deciduous stems per hectare, based on a 40 quadrat sample. Look at previous measurements deciduous counter to give you a good idea of the number of deciduous trees previously tallied. When the three deciduous trees are tagged, take the tallest 3 trees and also mare than 1 species if possible. Once a tree that has been previously counted only grows >=1.3m the tree is tagged and measured.

3.8 AREA SIX

a. Map

This area of the tally form visually represents the quadrat sampling area in terms of the trees tallied within the quadrat and, the seedbed calls on a sub-quadrat basis. Every 5.0 m^2 quadrat is made up of 20, 0.25 m^2 sub-quadrats. In the upper right hand corner of every sub-quadrat is a box in which the current seedbed code can be entered. The figure below is an example of how the map is used. At this point in time, the information on the map is not keypunched.

16	Seedbed Code	17	Seedbed Code	18	Seedbed Code	19	Seedbed Code	20	Seedbed Code
15	Seedbed Code	14	Seedbed Code	13	Seedbed Code	12	Seedbed Code	11	Seedbed Code
6	Seedbed Code	7	Seedbed Code	8	Seedbed Code	9	Seedbed Code	10	Seedbed Code
5	Seedbed Code	4	Seedbed Code	3	Seedbed Code	2	Seedbed Code	1	Seedbed Code

3.9 AREA SEVEN

a. Comments Section

The comment section provides an area for special notes/observations that may be of use in analysis or future remeasurements. It does not have any direct link to other parts of the tally form and is not keypunched. The first and last tally forms of a given set from a plot usually contain some descriptive data on the plot.

4.0 DATA STORAGE/ANALYSIS

4.1 Data Storage

In 1985, the Forest Management Branch (former Reforestation Branch) determined that the Monitor Plot data storage technique utilized at that time was inefficient. Up to 1985, data was stored at the University of Alberta on mainframe ASCIFORTRAN format. It was decided that the data needed to be on record in the Forest Management Branch (former Reforestation Branch). .

Monitor Plot data is highly structured and layered, a package was needed that could cope with this structure. What was chosen was a IBM-AT and the FOCUS package. The advantage of this was that several other projects in the Branch were using this package, and expertise was locally abundant.

All data collected to date is stored on the IBM-AT hard disk in the Forest Management Branch (former Reforestation Branch). The data is backed-up on floppy disks also in the Forest Management Branch. Current needs for storage capability in the Branch are about 10 megabytes, which increases by about three megabytes annually.

In 1989, it was decided to extract the database from FOCUS for easier access to individual tree data by plot. With the introduction of the PC 9800 datalogger in the field, it was necessary to get an accurate file of the trees measured in the previous measurement and to exhibit this individual tee data as the tree was being remeasured.

The program SAS is presently used to make up the files that are read by the PC 9800. Each plot has its own subdirectory on the working disks (3.5 inch), 1.2 meg backup disks, and are on a hard drive.

All data are stored in the server and are backed up every year.

4.2 Analysis

The Analysis of Monitor (Survival) Data is an ongoing process, spanning the life of the project. Initially summary statistics will be complied for each plot, as they become available (e.g. after each field season). More detailed analyses of data will be undertaken as subsequent remeasurements are completed (year 4 to 15).

As trends and consistencies in the data become apparent, they will be studied in detail. From this, models of juvenile stand initiation and growth will be constructed. This information will aid in providing new management recommendations and/or prescriptions for improved stand establishment.

A tentative routine for analysis of the Monitor Plot data is outlined as follows:

PHASE I – 3 YEARS – Report on plantation at 3 years of age, scarification effects after three years.

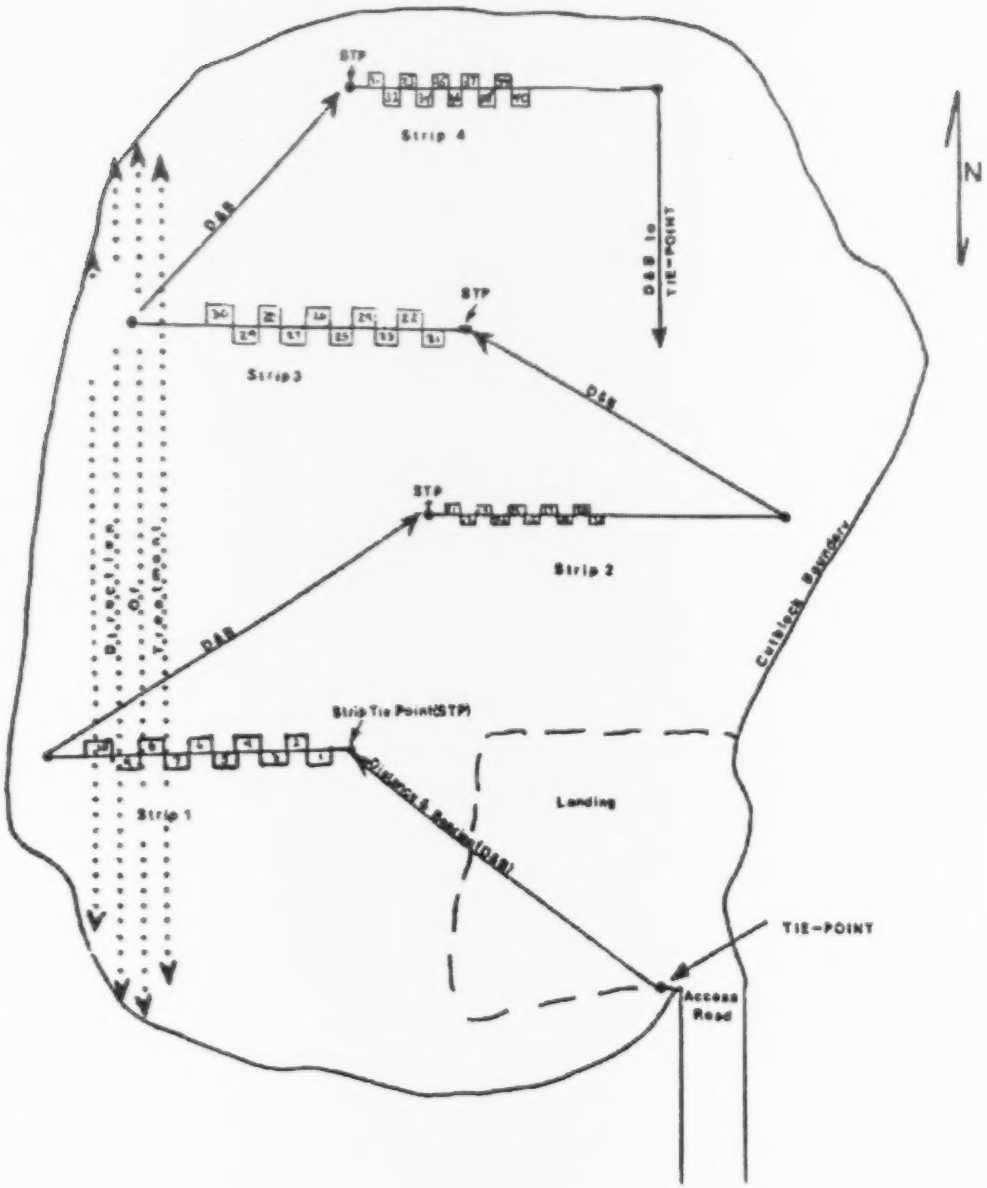
PHASE II – 5 YEARS – Comparison of similar blocks at 5 years of age.

PHASE III – 7 YEARS – Comparison of grouped blocks to results from regeneration surveys.

PHASE IV – 10 YEARS – Data manipulation for initial construction of models of juvenile stand establishment and growth.

PHASE V – 40 YEARS – Final report. Construction of model juvenile stand development.

Typical Monitor Plot Layout in a Cutblock



5.0 PHYSICAL LAYOUT – TYPICAL PLOT LAYOUT IN A CUTBLOCK

ECOREGION KEY

1. Boreal Subarctic
2. Boreal Northlands
3. Boreal Mixedwood
4. Boreal Foothills
5. Boreal Uplands
6. Subalpine
7. Montane

6.0 ECOREGIONS

7.0 MONITOR PLOT TALLY FORM

Alberta FORESTRY, LANDS AND WILDLIFE
Alberta Forest Service

RP 101
(Rev. 11/87)

MONITOR (SURVIVAL) PLOT TALLY CARD

AREA 1

PLOT NUMBER	DATE (Y Y M M D D)

Page ____ of ____ Surveyed By _____ Camera Frame: _____

FILL IN ONLY IF NEW PLOT OR INFORMATION HAS CHANGED		
AFS SEQUENCE NO.	LEGAL AOS	COVER
AREA	2	
ECOREGION	SITE	PREP / TREAT
ELEVATION	ASPECT / SLOPE	POSITION / EXPOSURE
TEXTURE	DRAINAGE	N DEPTH
VIABLE SEED	GERM %	HARVEST EQUIP / RETREAT TYPE
SRD DATE (Y Y M M)	SCAR DATE (Y Y M M)	TREAT DATE (Y Y M M) / RETREAT DATE (Y Y M M)

QUAD NUMBER	FILL IN ONLY IF NEW PLOT OR INFORMATION HAS CHANGED			DECIDUOUS FREQUENCY		
	PRIME COMPS	SECOND COMPS	SEED SOURCE	AW	PB	BW
	AREA		3A			
SEEDBED %	1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 2 0					

AREA 2

TREE NUMBER	FILL IN ONLY IF NEW TREE OR INFORMATION HAS CHANGED							HEIGHT (cm)	CALIPER (mm)	COMP INDEX	DAM OR DEATH	V	COND
	SPECIES	QUAD	S M	P MEAN	P YEAR	MICRO LOC	CRNG SR						
	AREA					AREA							

MAP

16 SEEDBED CODE	17 SEEDBED CODE	18 SEEDBED CODE	19 SEEDBED CODE	20 SEEDBED CODE	
15 SEEDBED CODE	14 SEEDBED CODE	13 SEEDBED CODE	12 SEEDBED CODE	11 SEEDBED CODE	
		AREA 2			
6 SEEDBED CODE	7 SEEDBED CODE	8 SEEDBED CODE	9 SEEDBED CODE	10 SEEDBED CODE	
5 SEEDBED CODE	4 SEEDBED CODE	3 SEEDBED CODE	2 SEEDBED CODE	1 SEEDBED CODE	

COMMENTS: _____

AREA 1

8.0 CODE DESCRIPTIONS

SITE CATEGORIES

VEGETATIVE COVER

(2) GRASSES

Coverage by grasses or sedges may be sparse, clumped or in the form of a mat. The percent coverage is determined using the area of the densest part of the canopy. It may be difficult to judge the canopy in tall leaning grass. Where thin leaning grasses do not have a dense canopy, the basal area of stems should be used to determine coverage. Tall leaning grasses that originate outside of the plot should not be included in the evaluation.

(3) MOSSES

Coverage can be clumped or in the form of a mat. Coverage of a particular area should be determined as described in Section A: Site Condition Categories. However, coverage includes all the surface area occupied by mosses rather than the densest canopy area. Moss coverage on logs or debris suspended over the ground should not be included in the evaluation.

(4) HERBS

As per grasses and mosses, see previous section for determining percent cover. Tally this code if herb coverage is greater than 50 % of a particular area, or if herbs are the dominant vegetation (greatest percent coverage).

(5) SHRUBS

As above, this code will be tallied if dense canopy coverage exceeds 50 percent of a particular area of if shrubs are the dominant vegetation. Tall shrubs with high canopies (above 1.5 m) may not shade the ground surface, leaving the understorey exposed for other vegetation to establish. Coverage for shrubs with high narrow forms may best be represented by the area taken up by their stems and major branches. Where the canopy area should be represented by the area taken up by their stems and major branches. Where the canopy is dense enough to shade out competing vegetation, the canopy area should be coded for shrubs. Where the competing vegetation has established beneath a higher shrub canopy, the competing vegetation, the densest canopy area of the higher vegetation should be tallied. The shrub species are those that are used by Corns and Annas (see tally board information sheet).

NON-VEGETATIVE COVER CODES

(1) ROTTEN LOG

As previously mentioned, this non-vegetative code should only be tallied if it represents the greatest percentage coverage of a particular area. Rotten logs are usually embedded in the ground surface. The shape of the wood source is not easily discernible. The wood must have deteriorated to the extent where it is spongy, stringy and friable.

(6) SLASH

This is for dead wood, branches and treetops that have been redistributed by the scarification done on the block.

(7) FLOODED AREAS

This code describes areas that were inundated by water for a period of time long enough to damage or destroy all on-site vegetation. These areas typically include the bottom of plowed trenches and deep gouges on bladed sites. Often such areas can be identified by ring-like deposits of salts and litter just above the depression. This call can be repeated in subsequent remeasurements if it is obvious that flooding is sporadic, and to varying degrees.

(8) ORGANIC/NON-ORGANIC DEBRIS

Are areas where no seedbed exists due to partial or complete coverage by (scarification) debris. Slash, fallen snags, solid stumps, gravel and rocks are examples of such debris. This debris may be scattered over the site, piled in clumps or may rest above the site (e.g. fallen snags that block out all light sources).

DISTURBANCE CODES

(9) MILD DISTURBANCE

Describes a duff disturbance only, with no mineral soils exposure. Mixed LFH layers or displaced litter material are indicative of this site condition. Examples of mild disturbances include duff depression by cat tracks, light anchor chain dragging, slight surface erosion, and shallow disturbances along skid trails.

(10) SHALLOW/MIXED DISTURBANCE

This code describes a shallow disturbance where mineral soil and organic material are mixed together. Both components must be visible. A and/or B horizons may be exposed by must be mixed with organic matter. Examples of such disturbances include

shallow blading, severe anchor chain drag and mixing from plowing. This code can be used to describe re-disturbances such as erosion, trampling by wildlife, or large-scale frost heaving of the exposed surface areas.

(11) MEDIUM DISTURBANCE

Describes a disturbance where the A and/or B-horizon are exposed and there is little or no organic material visible. This site condition is commonly found on lightly bladed sites, along the edges of ripper trenches, or in the deepest part of the bracke scalp (depending on the depth relative to the soil profile). Moderate water erosion may create this site condition by removing the soil organics. This call, when used in the second and subsequent measurements, describes a redisturbance to the site (e.g. large scale soil slumping).

(12) DEEP DISTURBANCE

Describes a deep disturbance where the B and/or C-horizons are exposed. This site condition consists entirely of mineral soil with the organic layers and A horizon removed by a disturbance (scarification or erosion). This condition is found in the deepest parts of trenches and gouges formed by site preparations. Examples of these disturbances are plow trenches, deeply bladed sites, water eroded gullies or steep slope, and cavities formed by the wholesale removal of stumps.

(13) MINERAL SOIL OVER DUFF

Describes a site where soil from an adjacent disturbance has need deposited onto another surface. This soil must be extraneous to the site. It must be mineral soil only and free of organics. It cannot be an overturned duff mat. The soil can be loose or in an aggregate form. The soil must be deep enough to completely cover the original surface. This site condition can be found on plowed sites where soil has been thrown back from a trench. Soil washed onto an undisturbed litter layer by erosion would be an example of an applicable redisturbance call using this code.

(14) INVERTED DUFF

Describes a site condition where an extraneous sod or duff mat is deposited on an area with the vegetation facing down. The sod must be vegetated with attached mineral soil on top. The vegetated side must be in contact with the ground surface. The most common example of this site condition is an inverted bracke scalp.

(15) DISPLACED DUFF OVER DUFF

This code is similar to the inverted duff code. Here an extraneous sod or duff mat is removed and deposited on another surface with the vegetation facing up. The soil surface of the displaced sod must be in contact with the ground. This site condition can be found along some plowing trenches. Down slope movement of a duff clod on a measured site would be an example of a re-disturbance using this code.

(16) BURNED AREAS

Is a disturbance site code that describes areas of duff, vegetation or debris that were recently burned. Evidence of the fire must clearly show that it passed over the site within the last measurement period. Only if another fire passes through the site at a later date should this code be tallied twice. Charred logs or snags that happen to fall on a site after they were burned are not to be included when deriving a surface coverage figure.

MIXED SEEDBEDS

(17) ORGANIC MATERIAL

This site condition is to be applied following a disturbance and before vegetation is established. There should be very little or no mineral soil exposed. The ground surface area consists entirely of duff, dead plant material or organic matter. The organic material must be deep enough to completely cover the mineral soil. As described in section 3.2, this code must comprise the greatest percentage of area to be tallied.

(18) MIXED ORGANIC MATERIAL AND MINERAL SOIL

This code describes a potential seedbed where organic material is mixed with mineral soil. Both components must be visible. This code is similar to the disturbance site condition code (10) – Shallow/Mixed Disturbance. However, this code is not used during establishment calls with disturbances. The mixed potential seedbed code need not be limited to shallow disturbances. The mixed potential seedbed code need not be limited to shallow disturbed sites. Sites that have settled after a disturbance and have received deposits of organic material may be tallied using this site condition code.

(19) MINERAL SOIL

This potential seedbed code describes and area whirr there is only mineral soil exposed. There is very little or no organic material visible; and very little if any, vegetation established yet.

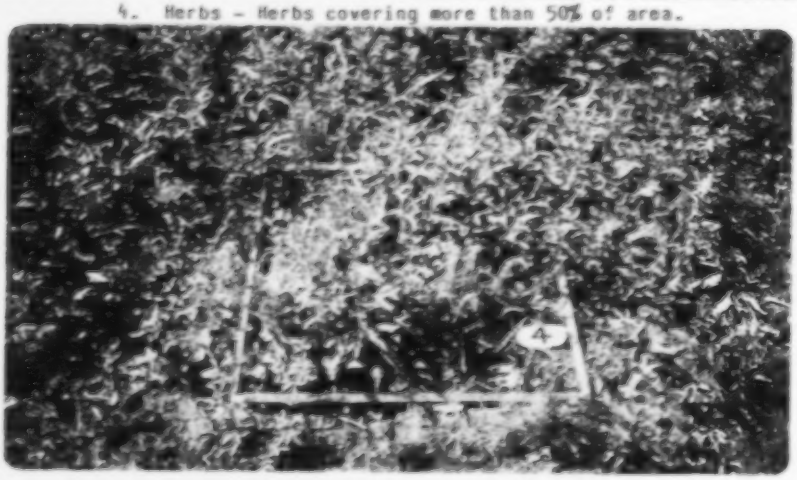
(20) NO SEEDBED

This code describes sites where seedlings cannot establish. Generally, this code corresponds to the non-vegetative site condition code, (8) – Organic/Non-Organic Debris, and the disturbance code, (7) – Flooded Area.

9.0 MONITOR PLOT PHOTOGRAPHS

2. Grasses - Either clumped or in a mat.

4. Herbs - Herbs covering more than 50% of area.

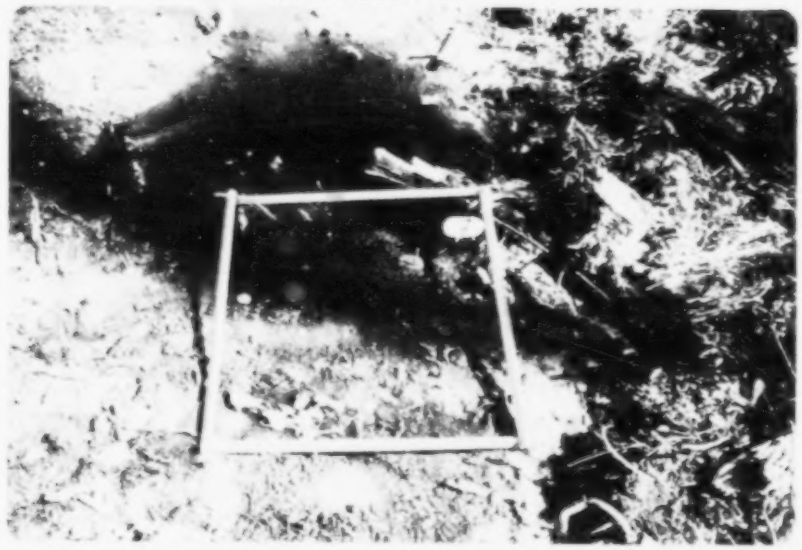


5. Shrubs - canopy coverage more than 50% or shrubs dominant vegetation.

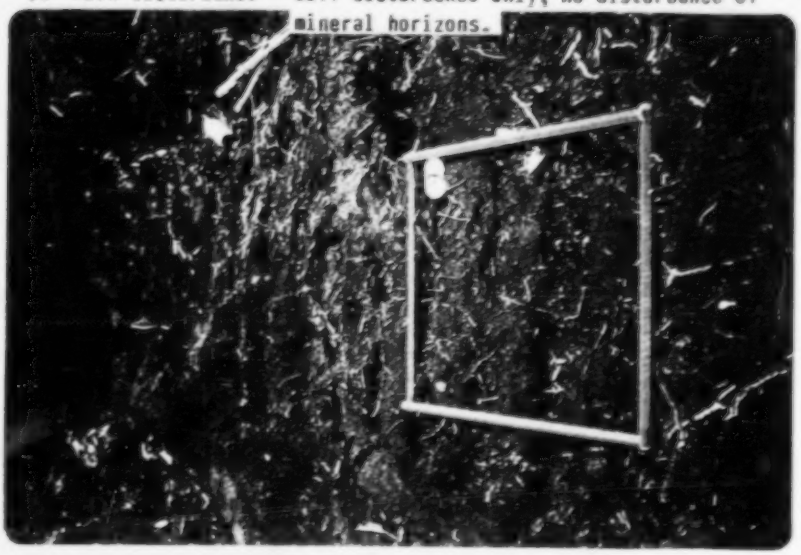
6. Litter Layer - no visible scarification.

8. Organic/Non-Organic Debris - stumps, slash, rocks, etc.

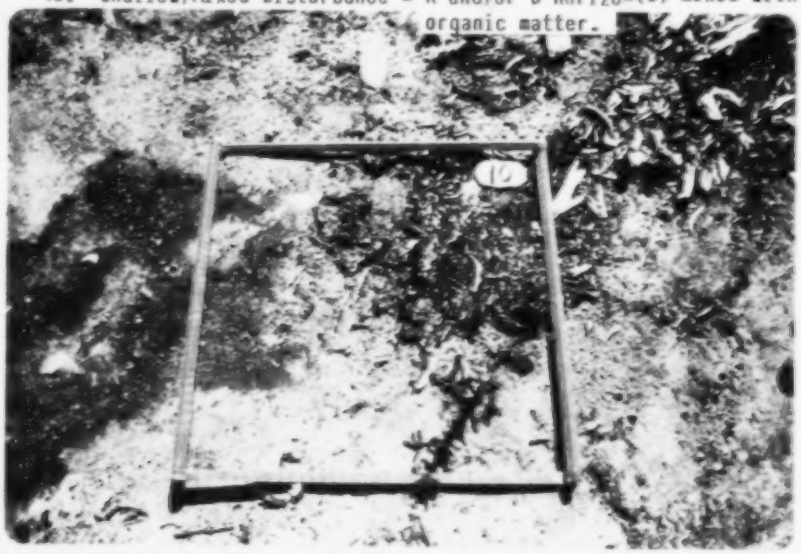
7. Flooded Area



9. Mild Disturbance - duff disturbance only, no disturbance of mineral horizons.



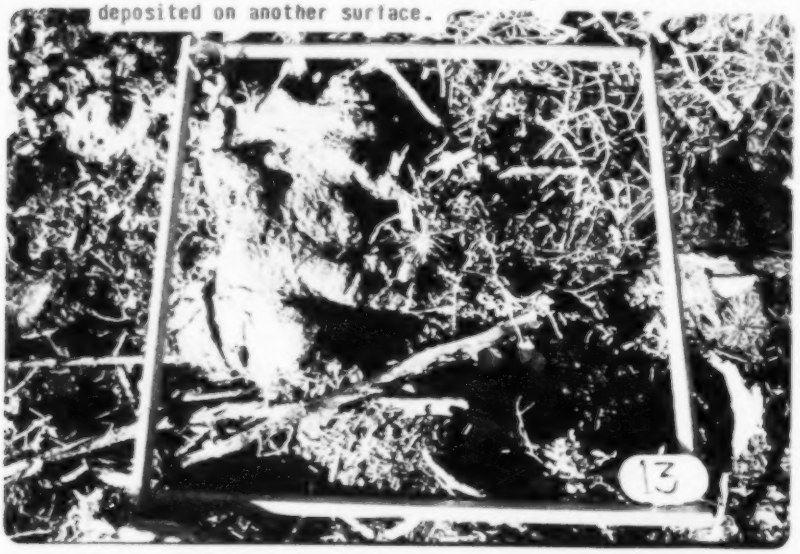
10. Shallow/Mixed Disturbance - A and/or B horizon(s) mixed with organic matter.



11. Medium Disturbance - A and/or B horizons mixed with little or no organic matter.

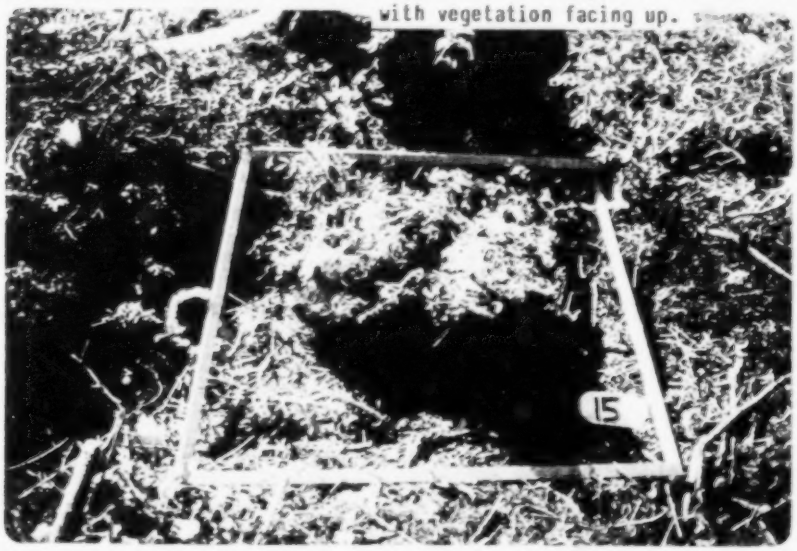
12. Deep Disturbance - B and/or C horizon(s) mixed, A removed.

13. Mineral Soil over Duff - soil from adjacent disturbance deposited on another surface.

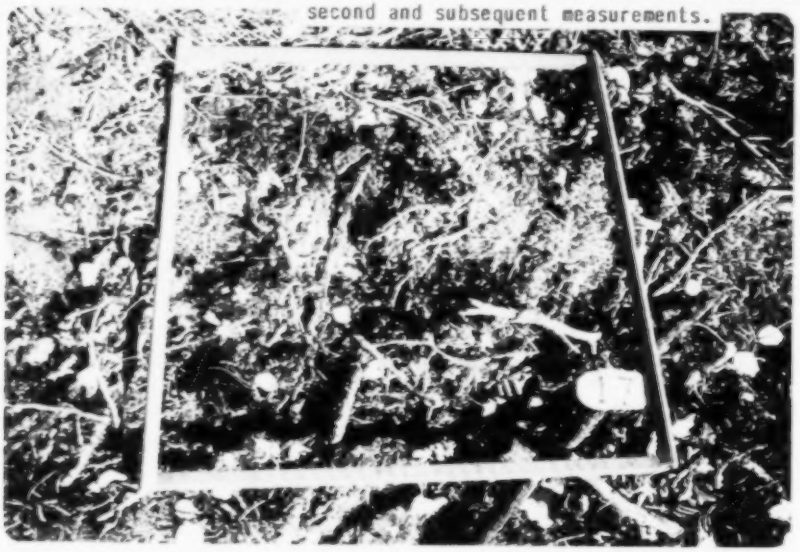


14. Inverted Duff - extraneous duff deposited on an area with vegetation facing down.

15. Displaced Duff over Duff - extraneous duff deposited on an area with vegetation facing up.

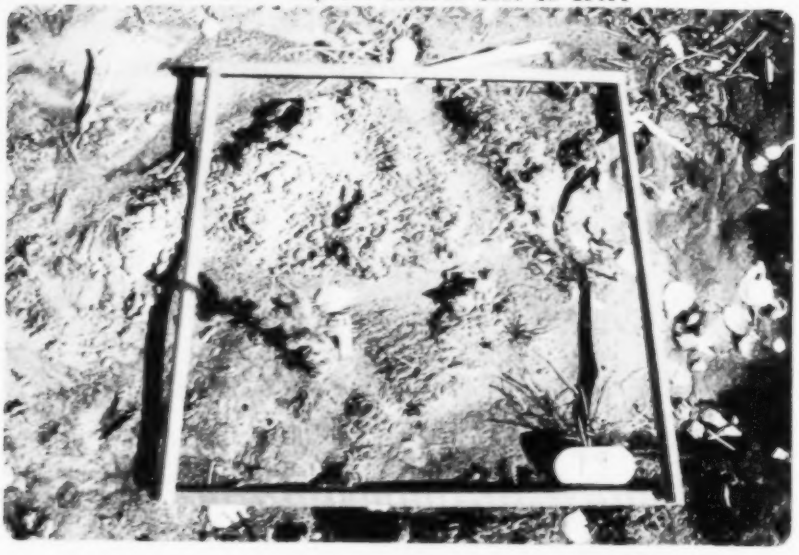


17. Organic Material - mineral horizons completely covered used in second and subsequent measurements.



18. Mixed Organic Material and Mineral Soil - potential seedbed where organic material mixed wit mineral soil.

19. Mineral Soil - exposed mineral soil on site.



10.0 ELEVATION OF BENCHMARKS

LOCATION	ELEVATION (METERS)
ATHABASCA	610
ASSUMPTION	305
BLAIRMORE	1291
CALLING LAKE (RS)	598
CASTLE (RS)	1364
CLEARWATER (RS)	1280
COLD CREKK (RS)	792
COLEMAN	1341
CYNTHIA	914
DRAYTON VALLEY	860
EDSON	924
ELBOW (RS)	1400
FORT MCKAY	260
FORT MCMURRAY (AIRPORT)	369
FORT VERMILLION (RS)	247
FOX CREEK	817
GHOST (RS)	1417
GRANDE CACHE (RS)	1250
GRANDE PRAIRIE (AIRPORT)	669
HIGH LEVEL (AIRPORT)	338
HIGH PRAIRIE	594
HIGHWOOD (RS)	1493
HINES CREEK (RS)	661
HINTON	1013
KEG RIVER	405
KINUSO (RS)	590
LAC LA BICHE	546
LODGEPOLE	945
MANNING (RS)	460
MCLENNAN (RS)	627
NORDEGG (RS)	1320
PEACE RIVER (AIRPORT)	571
RED EARTH	534
ROBB (RS)	1130
ROCKY MOUNTAIN HOUSE	1015
RYCROFT	610
SHEEP (RS)	1494
SLAVE LAKE (AIRPORT)	581
SPIRIT RIVER (RS)	630
SUNDRE (RS)	1128
SWAN HILLS	1158
WABASCA (RS)	545
WANDERING RIVER (RS)	564
WHITECOURT	741
VALLEYVIEW (RS)	762

11.0 REFERENCES

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Smith, W.H. 1980 *Tree Pathology, a Short Introduction.* Academic Press. New York, New York.

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Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

PSP MANUALS MASTER CONDITION CODE LIST

MARCH 2005

Public Lands and Forests Division
Forest Management Branch
8th Floor, 9920 – 108 Street
Edmonton, AB
T5K 2M4

Phone: (780) 427 - 8474
Or visit the website: http://www3.gov.ab.ca/srd/forests/psp

CONDITION CODES

CODE	DESCRIPTIONS	CODE	DESCRIPTIONS
00	Healthy	47	Witche's Broom
01	insects	48	Frost Crack
02	Disease	49	Dying
03	Rabbit Browsing	51	Conks/Blind Conks
04	Shepherd's Crook	52	Open Scars
05	Browsing (Other animal)	53	Burls and Galls
06	Fire	54	Fork
07	Mechanical	55	Pronounced Crook
08	Windthrow	56	Broken Top (DBH > 9.1) (No CC) (see "24" for DBH <9.1)
09	Climate	57	Limby
10	Flooding	58	Severe Lean (No CC) – see code #35
11	Poor Planting	59	Broken Stem (>=10cm DIB at Break DBH >9.1) (No CC)
12	Suppression	60	Generic woodpecker feeding (often smaller species)
13	Frost Heaving	61	Dead and Down (No CC)
14	Erosion	62	Stem Insects (Bark + Sawyer Beetles)
15	Missing	63	Stem Disease (Cankers)
16	Dead Top/Dieback	64	Foliar Insects
17	Poor Seedbed	65	Foliar Disease (Needle blights + rusts)
18	Herbicide	66	Stem Form Defect (>=7.0cm DIB at point where stem form begins)
19	Western Gall Rust (only on Pine)	67	Closed Scars
20	Armillaria Root Rot	68	Atropellis canker
21	Moldy Planting Stock	69	Comandra Blister Rust
22	Multiple Leader	70	Elytroderma needle cast of pine
23	Poor Form	71	Hypoxylon Canker
24	Broken Top (DBH <9.1) (see "56" for DBH > 9.1)	72	Spruce cone Rust
25	Dead Tree Standing (No CC)	73	Stalactiform Blister Rust
26	Snow Press (No CC)	74	Tomentosus Root Rot
27	Dead Top Dieback with NEW Leader	75	Spruce Spanworm
28	Sucker(s) (from OLD Stump)	76	Spruce Cone Maggot
29	Cut down	77	Spruce Cone worm
30	Terminal Weevil	78	Eastern Spruce Budworm
31	SW Gall Adelgid	79	Mountain Pine Beetle
32	Tent Caterpillar	80	Spruce Beetle
33	Root Collar Weevil	81	Spruce Needle Rust
34	J-Root	82	Yellow Headed Spruce Sawfly
35	Leaning (No CC) – see code # 58	83	Large Aspen Tortrix
36	Same Stump	84	Excavations by woodpeckers
37	Unknown	85	Yellow-bellied sapsucker feeding
38	Pitch Moth	86	Small mammal feeding on tree bole
39	DBH Taken on New Leader	87	Small Cavity
40	Nutrient Deficiency	88	Large Cavity
41	Mouse (feeding)	89	Hollow tree or hollow bole section
42	Ungulate feeding/rubbing	90	Beaver (feeding/harvesting)
43	Domestic livestock (rubbing)	91-96	Hawksworth Mistletoe Rating System
44	Nest	97	Available for future consideration
45	Other mammalian/avian evidence	98	Data changed by office
46	Sweep/Bow/Bend	99	Do not look for tree

Note: No CC means no crown class.

CONDITION CODES DESCRIPTION

Condition Codes		Description
00	Healthy	No Defect.
01	Insects	Damage or mortality due to destruction of plant parts or tissue by insects. Look for evidence of eggs, egg cases, nests, chewed plant parts, etc. Similar signs on plants located off site may aid in identification of insect mortality.
02	Disease	Damage or mortality caused by disease or fungi. Cankers, discoloration, rust spotting, fungal coverings, etc. help to identify mortality under this code.
03	Rabbit Browsing	Trees killed or damaged by rabbits can be identified by clean, sharp cut marks along the branches and stems (approximately 45° angles). Chewed bark and needles also indicate rabbit damage.
04	Shepherd's Crook	Damage results in blackening and wilting of young shoots and leaves. Tips of the blackened shoots often bend back. On older leaves brownish black, irregularly shaped spots appear.
05	Browsing (other animals)	Mortality or damage due to browsing by ungulates or other animals (e.g. moose, cattle, beavers). Look for chewed tops with rough cuts or breaks.
06	Fire	Mortality or damage due to actual burning of the seedling or scorching by nearby flames. **Not to be used when seedlings are killed by sun scald**.
07	Mechanical	Trees killed or damaged by mechanical or physical means such as scarification machinery, trampling or crushing by animals, etc. Stem scars and rough breakage help to identify mortality under this code.
08	WindThrow	Damage or mortality due to crushing by fallen or displaced logs, snags, branches, uprooted trees, etc.
09	Climate	Trees damaged or killed solely by climatic factors. These include death by freezing, sun scald, severe desiccation, ice accumulation, red belt, etc.
10	Flooding	Trees damaged or killed by drowning alone. Look for evidence of high water marks on the seedling, or in the immediate area. Pull tree out of ground and check roots to see if the root outer coverings is falling off and is blackened.
11	Poor Planting	Damage or mortality due to improper placement of nursery stock (hand or mechanical planting). Trees may have been planted too deep, too shallow, too loosely, or at an acute angle.
12	Suppression	Trees which have been suppressed by the surrounding vegetation for a period of time long enough to damage or kill them. Mortality may be due to severe lack of light, water, nutrients (removed by the competition) or by physical smothering (i.e. heavy grasses). Reference to the previous year's damage tally may help in determining this mortality call. A tree that is over topped by grass or shrubs is not necessarily suppressed. Look for a spindly main stem with very few long needles spaced wide apart or evaluate the last five increments. If the tree has only grown 1cm a year, it is probably suppressed.
13	Frost Heaving	This code is used only when mechanical frost action can be clearly identified as the direct cause of damage or mortality. Usually upheaval and separation of the seedling's root system from the soil occurs as a result of ice lens formation. This is most commonly associated with containerized seedlings planted in silty soil.
14	Erosion	Damage or mortality due to the removal of the seedling's seedbed, by the forces of water, wind or soil slumping. Trees killed by partial or total burial (deposited soil or organic matter) would also be tallied using this code.

15	Missing	This code is to be used when a seedling from the previous year's measurement cannot be located. It can also be used where the seedling was removed from the site and probably died (i.e. tag found, no morphological signs of live seedling remaining). Using in conjunction with code 25 **ONLY**.
16	Dead top/Dieback	Top is dead (die back) without any indication of insect or climate (frost) damage. See Figure 4.31
17	Poor Seedbed	This code is to be used only when the cause of death or damage for a seedling can be traced to the type of seedbed on which it is growing. In most cases the seedling will show signs of desiccation due to the poor moisture holding capacity of the seedbed material (e.g. rotten logs, dry clay).
18	Herbicide	Should only be used when the cutblock (or parts of the cutblock) has received a recent herbicide treatment; either before or after the stock was in place. Spruce seedlings exhibit needle loss and/or reddish brown coloration of stems and foliage. Deciduous species exhibit yellowish/brown leaf mottling and dieback of terminal growth. Hexazinone causes reddish brown coloration of conifer foliage and needle loss. Deciduous foliage turns red to black. Glyphosate causes chlorosis especially in new growing shoots. 2,4-D causes rapid growth and spiralling and twisting. If applied during conifer flush bad dieback similar to frost damage may occur. Often chemical damage will also be indicated by phytotoxicity spotting on exposed foliage.
19	Western Gall Rust (only in Pine)	This code is used when Lodgepole pine damage or death can be attributed to Western Gall Rust. This is usually clearly identifiable due to swelling of succulent tissue (and subsequent formation of a gall) and the bright orange spores produced in that affected area. This gall can be on the main stem or a lateral branch.
20	Armillaria Root Rot	This code is utilized when a seedling is damaged or killed by Armillaria Root Rot. Identification of the disease is in recognizing mycelial fans of the cambium of damaged and dead trees. Pull tree out of ground and examine root collar.
21	Moldy Planting Stock	This code is usually used on Bareroot Planting Stock. Grey mold will usually be found around the root collar and lower branches.
22	Multiple Leader	When a tree has two or more leaders, but is otherwise healthy this code should be entered. The tree is considered multiple leader if all leaders are within 5cm (height) of each other. This code also applies to saplings and regeneration that appear forked. Be aware of normal branching of deciduous trees.
23	Poor Form	This code is used on trees, which exhibit a general poor form, due to previous damage. DBH < 9.1 See code 66 for >9.1 DBH
24	Broken Top (DBH <9.1) (see "56" for DBH > 9.1)	It should be used as long as the broken top is noticeable and has some effect on the growth of the tree.
25	Dead Tree Standing (No CC)	Tree has no signs of being alive. A standing dead tree is one that is dead but still standing. No green foliage or buds present. The tree must be able to withstand a firm push. Record a diameter and species but do not record height. Pound nail into tree. **No crown class**.
26	Snow Press (No CC)	This code is normally used for trees that show signs of being pressed down to the ground for a few years after germinating. May Happen to bigger trees. See Figure 4.8
27	Dead Top Dieback with New Leader	This refers to stems that have had previous leader damage and a new leader has formed.
28	Sucker(s) (From Old stump)	Refers to stems that have been cut-down through thinning and have started to sucker. Do not re-use the previous stem number, but assign a new number to each sucker.
29	Cutdown	Self explanatory.
30	Terminal Weevil	Terminal leaders of Pine or Spruce bend over and die. Two or more years growth are affected. **Bore Holes** which are exit holes for the larvae **MUST** be present to

		use this code.
31	SW Gall Adelgid	Adelgid galls on spruce located at the end of new growth and may persist for many years.
32	Tent Caterpillar	A tent of silk forms on the tree and the caterpillars defoliate the tree.
33	Root Collar Weevil	This weevil feeds mainly on Sw, Pj and Pl. They feed in the bark and cambial area of the host tree at or below the duff surface, causing copious flows of resin. The tunnels often girdle small trees. This insect allows root rots to enter the tree.
34	J-Root	This code is used after the tree has had a poor planting code in the previous measurement.
35	Leaning (No CC) see code 58	Tree leaning more than 20% off of vertical axis.
36	Same Stump	Used when 2 or more trees can be distinguished above ground level but below DBH. Used a lot on Deciduous that have been cutdown and resprouted at stump.
37	Unknown	This condition code is to be used only when there appears to be something affecting the tree but the other condition codes do not describe the situation. This would include burnt trees etc. A description of what is affecting the tree should be included as well in the comments column. In the event that this code is used for more than 5% of the tallies, it is up to the crew leader or a forester to decide on the cause of the condition.
38	Pitch Moth	Primary host is Lodgepole Pine. May weaken or kill the terminal leader, resulting in stem deformities and height growth reduction. Blisters are mainly on main stem and are characteristic resin coated up to 20mm in diameter.
39	DBH Taken on New Leader	
40	Nutrient Deficiency	This may occur on blocks that have had the humus layer removed by scarification (i.e.; Blade). Trees are chlorotic and usually in bare mineral soil. Usually noted on spruce. May be confused with flooding damage.
41	Mouse Feeding	Mice and voles can girdle seedlings and consume seeds. See Rangen and Roy (1997) for more detail.
42	Ungulate feeding/rubbing	Ungulate feeding on twigs is generally recognized by the ragged appearance of twig terminals. Rubbing of trees as antler rubs and feeding on bark also occurs; these conditions are further described in Rangen and Roy (1997). Antler rubs can also be associated with "scrapes" (smaller patches of scraped ground) and small tufts of hair on twigs. If the bark on aspen trees has been consumed ensure that ungulates (as opposed to other mammals) are responsible. The extent of the bitten area, track identity and grooves that indicate tooth size and pattern should all be inspected in order to differentiate ungulate bark feeding from similar feeding by small mammals (i.e. see code number 86 and applicable photograph).
43	Domestic livestock (rubbing)	Rangen and Roy (1997) describe rubbing of trees by livestock; rubbed trees are occasionally seen in areas where cattle grazing occurs. If this code is used, ensure that other signs in general area (i.e. presence of cattle droppings, cow trails and grazed vegetation) also supports this.
44	Nest	This code indicates the presence of a nest on a given tree in the PSP. It refers only to an "open" nest; cavity nests are excluded from this category, as it is difficult to ascertain if a given cavity is indeed used as a nest site. Field guides that assist with the identification of "open" nests are available (see Harrison 1979). Of particular importance are colonial complexes of large nests on islands in lakes. Mammalian nests also exist and should be indicated as such if this is known. To do this, use the comments section which applies to a given tree and indicate as required. If the occupants of the nest can be identified, the identity can also be entered in the comments section.

45 Other mammalian/avian evidence	Other agents (i.e. bears, grouse, shrew, pocket gophers) which leave evidence on trees or leave evidence closely associated with trees are described in Rangen and Roy (1997). Pocket gophers leave soil mounds (Rangen and Roy - (1997). Bears can leave a characteristic series of claw marks on aspen trees, indicating that the tree was scaled, and rotted stumps/logs are also occasionally ripped apart. In addition, it has been suggested that bark on live trees is occasionally consumed (see Hiratsuka 1987 for a depiction). Ensure that ripped up stumps/logs, etc. are accompanied by other evidence of bear.
46 Sweep/Bow/Bend	Is a gradual bowing or curving of the main tree system. It has no decay significance but may cause a loss of volume in a sawlog.
47 Witches Broom	Yellow witches broom is the most conspicuous disease of spruce in the province. Can be recognized from a distance. See Figure 4.10
48 Frost Crack	A frost crack is a deep radial splitting of a trunk caused by an uneven shrinkage of the wood after a sudden drop in temperature. The cracks usually start at the base and extend up the trunk. They may re-opened repeatedly by wind stresses or a low temperature.
49 Dying	Tree is in distress and will die before next measurement.
51 Conk/Blind Conks	Conks appear most frequently on the underside of dead branch stubs or on the underside of live branches in the crown. Conks, by definition, are woody, shelflike basidiocarps (fruiting bodies) of wood-rotting fungi. See Figure 4.3
52 Open Scars	Open scars are wounds which have been penetrated through to the cambium. These wounds must not be healed over and may be caused by a variety of reasons such as fire, lightning, old blazing, machinery, animals, etc. Scars are considered to be entry points for decay fungi. Open scars are illustrated in Figure 4.4. Animal damage usually penetrates the cambium therefore code as an open scar. A common mistake is to call stem disease such as atropellis canker an open scar. See Figure 4.4
53 Burls and Galls	Burls are abnormal swelling of the main stem or branches resulting from abnormal wood cell development following disturbance to the cambial layer. A burl is illustrated in Figure 4.5. Galls are localized trunk and branch swelling of mainly tissue. There is little or no damage to the underlying wood.
54 Fork	Forks usually develop when there is malformation, injury or death of the terminal leader. Forks tend to be V-shaped and will only be recorded when above 1.3 m (DBH level). Forks below this point are recorded as same stump (condition code 36). Natural branching on deciduous trees is not to be recorded. Figure 4.6 demonstrates the difference between forks and natural branching.
55 Pronounced Crook	This condition develops from the death of the terminal leader or the breaking off of a forked leader. When this occurs, a lateral branch takes over apical dominance as shown in Figure 4.7.
56 Broken Top (No CC) (see "24" for DBH <9.1)	Broken tops occurs usually in the top third of the tree. **No Crown Class**.
57 Limby	A tree is recorded as limby if more than 75% of the tree has live, low sweeping branches. Usually branches on coniferous >2.0m on any part of tree could be considered limby.
58 Severe Lean (No CC) see code 35	A tree is considered leaning if it is standing greater than 20° off of vertical (see Figure 4.8). If the angle is greater than 45° to the ground, the tree has a severe lean. **No crown class if severe**.

59	Broken Stem (No CC)	A broken stem is recorded if the tree bole broken. Usually found in bottom 2/3 of the tree. **No crown class**.
60	Generic woodpecker feeding (often smaller species)	Figure 4.13 indicates feeding by woodpeckers. Species such as the Black-backed woodpecker and Three-toed woodpeckers will often leave signs like this on old coniferous trees, and Hairy and Downy woodpeckers typically peel off scales ("scale") and "peck" the bark as do Pileated woodpeckers in summer months (Conner 1979). Note the evidence of very small holes (arthropods) and holes made by the woodpeckers themselves. The appearance of tree trunks fed on in this manner is often reddish from a distance.
61	Dead and Down (No CC)	A dead and down tree is one that was previously tagged and measured in a PSP plot but at the present time is now dead and no longer standing. The cause of death must be by natural causes (i.e. windfall, beavers, insect or disease, etc.). **No crown class**.
62	Stem Insects (Bark + Sawyer Beetles)	This code is recorded when there is evidence of an insect infestation attacking the bole of the tree. Bark beetles are the most prevalent stem insects but sawyer beetles and others are included. Bark beetles, Dendroctonus spp., are a very serious problem in Alberta. The adult female enters the bark in early summer and lays eggs in the tree's cambium. The eggs overwinter and hatch as larvae in the early spring. Damage to the tree is done by the larvae eating the cambium and usually results in death. The tree will not turn red until the next summer. Other symptoms of attack are piles of "sawdust" (frass) at the base of the tree, entry holes in the bark, and pitch tubes (the tree tries to push the beetles out with resin). The beetles also carry a blue stain that causes further deterioration of wood quality. Beetles attack all species of pines, spruce, and Douglas fir. Sawyer beetle infestations are common in burned timber.
63	Stem Disease (Cankers)	All diseases that infect the main stem are documented with this code. Included in this code are cankers, rusts, rotten branches and root rot. Stem cankers are caused by fungi that invade stems and branches resulting in localized areas of infection in the bark and underlying wood tissue. Cankers may be annual or perennial. In perennial cankers the infected area may be eventually exposed to the underlying wood when the deadbark sloughs off. A common stem canker on lodgepole pine is Atropellis piniphila (Figure 4.9). Exudation of resin from the bark surface is the first external symptom. They are sunken elongated on one side of the trunk and indicate resin flow. This can cause a distortion in growth and a blue-black stain on the wood. Stem rusts are also included in this condition code. Rusts are host specific parasitic fungi usually requiring two alternating living hosts. Stems and branches may be girdled resulting in large malformations or even death. In particular, Endrocronartium harknessii on young pines is a serious problem in Alberta. Spruce broom rust, Chrysomyxa arctostaphi (see Figure 4.10), can also be noted but only if the broom is no longer green (i.e. red or missing needles). Large rotten branches typically appear on overmature, decadent trees and can be indicative of decay. Large rotten branches are those well below the base of the live Crown and are > 5 cm in diameter, are unweathered, appear punky, and are weeping. Often a black ring appears on the stem surrounding the branch. Some of the typical symptoms of Armillaria root rot are reddish brown or yellowish foliage; mycelial fans form between the bark and wood around the base; fungal (shoestring) strands in the soil surrounding the diseased roots and honey mushrooms growing around the base of the diseased tree.

64	Foliar Insects	This condition code pertains to all insects that infest parts of the tree off the main stem. Included in this category are the tent caterpillar, spruce budworm, jack pine budworm, spruce gall aphid, etc. The forest tent caterpillar, Malacasoma disstria, causes severe defoliation in hardwood stands in Alberta resulting in a significant reduction in annual growth. The spruce budworm, Choristoneura fumiferana, infests mature white and black spruce, and balsam fir stands. This insect attacks the buds and new needles. Their feeding spreads to old needles and eventually kills the tree. The jack pine budworm, Choristoneura pinus, attacks stands of jack and lodgepole pine and is a relatively new forest pest in Alberta. This insect feeds and spreads in the same manner as the spruce budworm.
65	Foliar Disease (Needle blights + rusts)	This code is used for all diseases that infect parts of the tree off the main stem. Needle casts and blights, and needle rusts are included in this condition code.
66	Stem Form Defects	This condition code is used when there is damage or a distortion resulting in a loss of volume. Used for trees >9.1 DBH. See code 23 for <9.1cm DBH. A sweep or bend is the gradual bowing or curving of the main tree stem. If has no decay significance, but may cause a loss of volume in a sawlog. Spiral grain is the twisting of the grain seen in exposed wood or in the direction of the bark fissures. Spiralling frost cracks and scars also indicate the presence of spiral grain. Windshake is a splitting in the wood along the grain or less frequently within an annual growth layer. It is caused by wind or snow stresses and is also known as ringshake.
67	Closed Scars	Wounds that had penetrated the cambium but have now healed over are considered closed scars. A closed scar is characterized by an irregular indentation in the bole of the tree that would result in loss of volume due to poor wood quality. Before healing over, the scar provided an entry point for disease. Frost crack is not included in this code.
68	Atropellis Canker	Widespread on pine, from small to large trees. Symptoms are elongated, sunken, cankers on the stem with copious yellowish resin flow. Wood is discoloured blue/black. Figure 4.9
69	Comandra Blister Rust	Pl and Pj are hosts. Local occurrence only. Infected stems are spindle-shaped with conspicuous swelling of the bark. Fungus is orange-yellow in early summer. Cankers are circular and grow laterally as quickly as longitudinally. They thus girdle the stem faster than stalactiform. It should not be confused with western gall rust, which is mainly a swelling of the wood. Alternate host is Indian Paint Brush.
70	Elytroderma Needle of Pine	Mostly on Pl. Current years needles turn red in fall. In severe cases only current needles remain, giving branches a "lion's tail" appearance.
71	Hypoxylon Canker	Hosts are aspen and balsam poplar. Canker starts as a slightly sunken orange-yellowish area on stem. Eventually girdles the stem and has an orange/black appearance. A mycelial fan on the cambium is a reliable field symptom.
72	Spruce Cone Rust	Rust is only on spruce cones. Cones become prematurely brown then orange-yellow. When spores are abundant, the forest floor has an orange colour.
73	Stalactiform Blister Rust	Pl and Pj are hosts. Local occurrence. Causes slight swelling of bark. Orange-yellow in summer. Cankers are elongated and grow faster longitudinally compared

		to Comandra. Alternate host is Bastard Toad Flax.
74	Tomentosus Root Rot	Most important on Sw and Sb. Symptoms are excessive branch mortality, thinning of crown and openings in the stand. Disease develops slowly (over 15-20 years) so is not so obvious in regenerating stands.
75	Spruce Spanworm	Chiefly affects aspen. Damage shows mostly as holes in the leaves. Resembles forest ten caterpillar but no pupal cases or egg masses on the foliage. Caterpillars are typically light green and have one prominent and two indistinct yellowish lines along each side of the body. The head is dark-brown.
76	Spruce Cone Maggot	No external symptoms. Dissected cone shows frass-filled spiral tunnel around the central axis.
77	Spruce Cone Worm	Feeding larvae expel frass, which adheres to silken webbing on cone surface.
78	Eastern Spruce Budworm	First symptoms are webbing and frass in buds or on previous year's needles. Later, webbing is spun on branch tips. By late June tree crowns appears rust brown.
79	Mountain Pine Beetle	Main host is Pl. Symptoms are standing dead trees with beetle exit boles about eye-level. Accumulations of pitch or sawdust are conspicuous around entrance holes bored into the bark of trees by adult beetles from mid-July to mid-August.
80	Spruce Beetle	Host are Sw and Se. Symptoms are standing dead trees with beetle exit holes about eye-level. Conspicuous boring dust accumulates on bark below holes until the wind blows it away.
81	Spruce Needle Rust	Feed on needles in the upper crown of the tree. Partly chewed needles and needle stubs impart a brownish color and ragged appearance to the foliage. No webbing present. Found on all spruce.
82	Yellow-Headed Spruce Sawfly	Discoloration of needles. May find dotlike sexual fruiting structures on needles. Infected needles drop prematurely.
83	Large Aspen Tortrix	Affected foliage has a clumped, irregular appearance and leaves do not move as freely in the wind as uninfested leaves. Larval instars feed within rolled leaves or within 2 or more leaves pulled together and secured with silken webbing.
84	Excavations by woodpeckers (likely Pileated woodpecker)	Feeding by Pileated woodpecker can occur on dead or scenescent deciduous and coniferous trees, and feeding holes (as indicated in the figures below) are thought to occur towards the base of the tree (Rangen and Roy 1997). Excavated holes indicate subcambial penetration (holes penetrate beneath the bark and into the sapwood) and large wood chips can be associated with excavations. Excavated feeding holes can be large (Figure 4.16). In such excavations, evidence of carpenter ants (burrows, sawdust) or other boring arthropods might also be found in the sapwood. In living trees with a sound bole, initial feeding holes might be more restricted such as that indicated in Figure 4.12. Elsewhere in North America, the Pileated woodpecker has been found to excavate holes extensively in winter and to a grater extent that other woodpeckers (Conner 1979). The Hairy woodpecker might also create deeper holes in trees, however, it is considered an opportunistic feeder (Sousa 1987) and spends a smaller portion of its time "excavating" during winter months (Conner 1979). In Iowa, it has also been found to generally feed at higher locations in trees (5-7m) (Sousa 1987). If this feeding evidence exists on a given tree, indicate in comments its extent (i.e. restricted, such as in Figure 4.16).
85	Yellow-bellied sapsucker feeding	Figure 4.14 illustrates the characteristic pattern of regularly spaced small holes left by Yellow-bellied sapsucker (also see Hiratsuka 1987 for another depiction of sapsucker feeding). These are often found on birch, however they also have been observed on willows, and have been reported on aspen and pine (Rangen and Roy 1997, Hiratsuka 1987).
86	Small mammal feeding on tree bole (hare,porcupine, squirrel, bushy-tailed	Figure 4.15 is an example of feeding by hare on small saplings. In this case the bark was bitten off. When hares feed on twigs, it is generally thought that twigs are clipped off in a characteristic razored fashion (Figure 106, Rangen and Roy, 1997). Small mammals such as porcupine, woodrat and squirrel might also feed on bark

	woodrat)	however, if such feeding evidence occurs high in trees, one could probably rule out hare because hare do not climb trees (also see Hiratsuka 1987 for a depiction of porcupine feeding on pine). Ensure other evidence (i.e. tracks, pellets, etc.) Supports a specific determination of the agent involved. Also refer to Rangen and Roy (1997) for more information on how to identify the specific causes of girdling and refer to Murie (1975) for assistance on identifying tracks if this is required. Evidence of squirrel feeding is common and could also be indicated, however, the value of this information is probably less valuable.
87	Small Cavity	Small woodpeckers create small cavities (approximately 5 cm in diameter) in snags and stubs (Figure 4.17), however, height of the cavity above ground probably varies. Among the species which might use such cavities are smaller woodpeckers, kestrel, chickadee, nuthatch, swallow, wren, flycatchers, and small mammals (etc). One could explore whether such cavities are occupied by rubbing the bark with a stick. Should a cavity be occupied the occupant (if known) should be identified in the comments section.
88	Large Cavity	A large cavity is a round/excavated opening greater than or equal to 10 cm in diameter (see Figure 4.18). The cavity in the figure was approximately 15 m high. Pileated woodpeckers have been known to excavate such cavities, however, a variety of species (birds as well as mammals) may use them as nest sites, roosting sites or dens. As in the case of smaller cavities, one could investigate the identity of the occupant by rubbing/tapping the bark of such trees with a stick. If might be possible to ascertain the identity of the tracks which are associated with the cavity, during winter, by checking surrounding snow cover and identifying tracks that appear to lead towards the cavity in the tree (see Murie 1975).
89	Hollow tree or hollow bole section	Hollow trees can be used as denning sites by bats and other birds and mammals. This condition code should be used to identify these sites.
90	Beaver (feeding-/harvesting)	Beaver girdle large trees in a characteristic fashion and evidence of their harvesting activities (i.e. cone shaped stumps) are well known to many. Refer to Rangen and Roy (1997) and Hiratsuka (1987) for more details.
91-96	Hawksworth Mistletoe Rating System	Dwarf mistletoes are parasitic flowering plants requiring living hosts. Mistletoe is usually recognized by swellings on branches and stems or by witches brooms. Heavy infestation makes trees susceptible to secondary attack (such as bark beetles), lower wood quality and growth losses (can be from 30-60%). The major tree hosts in Alberta are: lodgepole pine, Douglas fir and larch. Figure 4.11 illustrates the effect resulting from mistletoe infestations and the individual flowering plant. The Hawksworth Rating System for mistletoe is used to determine the severity of mistletoe infestation on individual trees. Figure 4.12 outlines instructions and gives an example of the use of the 6-class mistletoe rating systems (Hawksworth 1961, 1977). If a tree has mistletoe, record only the 90 series code, do not record 33 unless there is a second distinct foliar disease.
97	Available for future consideration	
98	Data changed by office	
99	Do not look for Tree	